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ABSTRACT

Intended for teachers and caregivers of severely handicapped individuals with impaired hearing, the manual provides information about hearing and audiological assessment. Section I presents an overview of the nature of sound and the structure of the ear. Section II describes a number of informal assessment procedures which can be carried out in the classroom. Section III, which makes up the bulk of the document, summarizes common audiometric procedures and presents a number of systematic programs and teaching strategies to help prepare severely handicapped students for testing by a clinical audiologist. A fourth section offers information necessary for understanding an audiogram and the amplification process. The final section discusses the educational implications of different degrees of hearing loss and the selection of communication modes and auditory objectives for severely multiply handicapped students. (Author/SW)

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AUDITORY ASSESSMENT AND PROGRAMMING FOR SEVERELY HANDICAPPED AND DEAF-BLIND STUDENTS

EC151052

THE BAY AREA
SEVERELY HANDICAPPED
DEAF-BLIND PROJECT

Auditory Assessment and Program Manual For Severely Handicapped Deaf-Blind Students

Bay Area Severely Handicapped Deaf-Blind Project
U.S.O.E. Contract #300-078-0338
U.S.O.E. Project Officer: Paul Thompson

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Introduction

This manual is intended for use by teachers and caregivers of severely handicapped individuals who have documented or suspected hearing loss and/or who fail to use what hearing they may have functionally. The transdisciplinary approach (Hutchinson, 1976; Conner, et. al, 1978) to educational programming for these individuals requires that the teacher communicate effectively with professionals from many fields - audiology, medicine, psychology, etc. - who are involved in serving students with multiple needs. In order to do so, the teacher of the severely handicapped must understand the basic mechanisms of sound and hearing, and must be familiar with basic terminology and procedures involved in audiological assessment and amplification. In addition, he must be able to use this information to develop and implement classroom programs based upon an individual student's auditory needs.

The goal of this manual is to provide teachers and caregivers with *basic* information about hearing and audiological assessment, and to make available to them a variety of classroom programs designed to prepare severely handicapped students for audiometric testing by a clinical audiologist (for example, establishing an operant in response to sound), and to assist in the remediation of specific auditory deficits (for example, teaching functional localization skills). It is *not* the goal of this manual to encourage audiological evaluations by teachers or caregivers in place of evaluation by audiologist. Formally testing the hearing of severely handicapped children requires training and should be conducted by qualified clinical audiologists. However, many severely handicapped children present an extremely complex assessment problem and are often considered untestable. Therefore, knowledgeable teachers can facilitate audiological testing by understanding the audiologist's goals and helping to prepare the otherwise "untestable" student for the test session.

Section I of the manual presents an overview of both the nature of sound and the structure of the ear. It also includes a brief description of common causes of hearing loss and deafness.

Section II describes a number of informal assessment procedures that can be carried out by the teacher in the classroom. These are based upon careful observation of the student's behaviors, including reflexive responses such as startling or eye blinking, and quieting or increasing activity in response to sound stimuli varying in intensity and spectral characteristics.

The bulk of the manual is in Section III, which summarizes common audiometric procedures (BOA, TROCA, VRA, play and audiometry, etc.) and which presents a number of systematic programs and teaching strategies to help prepare severely handicapped students for testing by a clinical audiologist. These programs use a stimulus shift paradigm to establish stimulus control of an operant response to auditory stimuli and were developed with students attending the federally funded Bay Area Severely Handicapped Deaf-Blind Project. Once a student has successfully completed these programs, he should be ready for formal audiometric evaluation.

Section IV presents information a teacher needs subsequent to audiological testing in order to understand an audiogram and to understand the amplification process. Procedures for regular maintenance of hearing aids and for troubleshooting common problems with aids are also included. This information is not a substitution, however, for personal communication with the audiologist.

Once a student has an amplification device or is found to have hearing within normal limits, he is ready for the functional auditory training programs included in Section V. Section V discusses the educational implications of different degrees of hearing loss and the selection of communication modes and auditory objectives for severely multiply handicapped students. The manual then describes systematic procedures for accomplishing functional auditory programming in the classroom. Again, procedures and programs were developed in the classroom of the Bay Area Severely Handicapped Deaf-Blind Project, and sample performance data from actual project students are included with the instructional programs.

Before utilizing this manual, a note of caution should be heeded. This manual is written for teachers who demonstrate the following competencies: 1) Familiarity with task analysis as an instructional strategy for severely handicapped students; 2) The ability to monitor student progress on instructional objectives by using daily data and to evaluate performance based on that data (cf. Haring, Liberty, and White, 1980); and 3) Understanding of the basic principles of behavior analysis, including principles of operant conditioning (cf. Kazdin, 1975). Without these competencies, successful implementation of the manual programs and procedures is doubtful.

I. Basic Information

The Nature of Sound

Sound is a wave phenomenon. Sound waves are produced when air particles are set into vibration. Two dimensions of sound which are particularly important in understanding hearing and hearing loss are frequency and intensity.

Frequency is basically the number of vibrations of air particles per second. Frequency is measured in terms of Hertz (Hz) or cycles per second (cps). The normal human ear has a frequency range of approximately 20-20,000 Hz. Sounds falling below or above this range cannot be heard by humans. Speech sounds, which are major concern for clinical audiology, occur mainly within the range of 300-4000 Hz. Hearing is typically tested from 250-8000 Hz.

The psychological attribute which corresponds to frequency is pitch. Low frequency sounds are perceived as low pitched sounds, while high frequency sounds are high pitched sounds. Middle C on a piano is a 250 Hz sound; one octave below middle C is 125 Hz. Other predominantly low pitched sounds include the bass drum, the hum of an air conditioner, and low male voices. Predominantly high pitched sounds include the doorbell, a violin, or a soprano voice. Speech sounds consist of vowels and consonants. Generally speaking, vowels are low frequency sounds and consonants are high frequency sounds. The implications of the differing frequencies of speech sounds are considerable, and are discussed in some detail below under Speech Acoustics.

Intensity corresponds to the psychological attribute of loudness. A measure of intensity is actually a measure of the pressure of the sound wave (sound pressure level, or SPL). The unit used in measuring intensity is the decibel (dB).

The range of useable hearing is from 0 dB to 120 dB SPL (threshold of discomfort). Another way of discussing hearing is in dB HL (Hearing Level). Hearing level refers to measurements made on an audiometer. 0 dB HL does not indicate the absence of sound, but rather it is the intensity required for a normal hearing person to detect sound. For example, 0 dB HL (Speech) is equal to 13 dB SPL (20 dB SPL under earphones). 0 dB HL of a tone may equal 10-25 dB SPL of the tone. To convert dB SPL (the physical presence of sound waves) to dB HL (the reading on an audiogram), one must subtract 7-25 dB (depending on the sound).

To appreciate the wide range of sounds the human ear can hear, it is important to remember that decibels are intensity *ratios*, and thus do not merely increase arithmetically. Twenty decibels (10 *plus* 10 decibels) does not correspond to a doubling of intensity, but rather to a 100-fold (10 *times* 10) intensity change. The range of intensities covered by a dB scale of 0 to 130 decibels is therefore considerable: The strongest sounds an average person can hear without pain can be as much as 10 million times greater in intensity than a sound which is barely audible (Denes and Pinson, 1963). Approximate decibel levels for various sounds are presented below:

20 dB SPL.....whisper at four feet
50 dB SPL....quiet auto ten feet away
60-70 dB SPL.... normal conversation at three feet
90 dB SPL..pneumatic drill at ten feet
110 dB SPL.....Hi fi at ten feet

These levels are approximate, but should provide a sense of the wide range of intensities the dB scale measures.

In addition to frequency and intensity, every sound also has *spectral* characteristics. Rarely is a sound simply the product of one frequency produced at one intensity level, as is the case with pure tones typically used in formal audiological testing. Rather, most sounds are complex sounds, consisting of several frequencies and differing intensities. The resulting interaction of these frequencies and intensities produces the spectral characteristics, or quality, of the sound.

Speech Acoustics refers to the study of the nature of speech sounds. Speech sounds belong to one of two main categories: vowels, which are produced with an unrestricted vocal tract, and consonants, which are produced through various constrictions of the air passing through the vocal tract. In terms of frequency and intensity, vowels are lower frequency sounds, generally having their most intense frequency components below 750 Hz. Consonants are composed of higher frequency sounds often consisting of a wide range of frequency components. In addition, vowels and consonants also differ in the amount of acoustical energy they produce. For an equivalent amount of vocal effort, the range between the loudest vowel ɔ, as in dog, and the softest consonant th, as in this, is 28 dB. Vowels are therefore the most intense sounds heard in speech, while consonants are considerably less intense.

Despite being softer, consonants carry the most information for speech comprehension. Consider, for example, reading aloud a telegram in which all vowels have been left out. Comprehension of the message would probably still be quite good. For example, 'chkbk stln. Snd mny c/o htl.'', is reasonably comprehensible. If, however, only the vowel sounds were left in and the consonants omitted, comprehension would be negligible. If the message were ''eoo oe. e oe c/o oe.'., its intelligibility would be dubious. Thus, while vowel sounds are the most readily heard, it is the softer consonant sounds which are most critical for speech intelligibility. Data exist showing that consonants above 1000 Hz provide 60% of speech intelligibility, while vowels below 500 Hz (which are the loudest speech sounds) provide only 5% of speech intelligibility (French and Steinberg, 1947).

Shouting at an individual with a known or suspected sensorineural hearing loss will do little to improve comprehension, because the vowels will become even louder while the consonants will continue to be less audible (because it is difficult to ''shout'' a consonant sound). Also for this reason, even mild or moderate hearing losses (in the 30-60 dB range for children) can have a significant effect upon speech intelligibility. For example, consider speech that is delivered at 70 dB SPL. The vowel sounds will be about 70 dB, however, the consonants will only be about 50 dB. Therefore, an individual with a 60 dB loss may miss hearing many of the consonants and speech understanding will be poor. In addition, verbal exchanges rarely occur in totally silent environments. Usually communication takes place against a background of low level environmental sounds. This background noise is typically low frequency. Low frequencies tend to have a masking effect on higher frequencies. Therefore, high frequency consonants in the speech message can be somewhat obscured by the additional low frequency noise present in the environment.

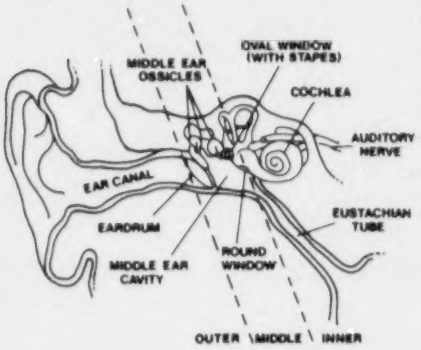
It should be noted, however, that for individuals with conductive type hearing losses (see page 7), it may be helpful to speak in a slightly louder than normal voice, because conductive losses typically affect low frequency vowel sounds. Therefore, increasing speech loudness may enhance speech comprehension for these individuals.

The complex nature of the relationship between the audibility and the frequencies of speech stimuli underscores the need for careful and thorough audiological evaluations. To provide effective amplification for speech, the most crucial of all auditory stimuli, the audiologist must determine the type of loss (discussed further below), the degree of the hearing loss, and the frequen-

cies at which the loss is present.

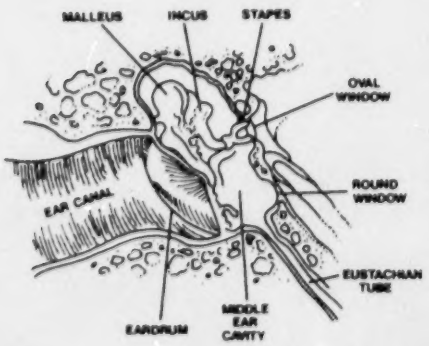
Structure of the Ear

The ear is typically considered in terms of three segments: outer, middle, and inner ear. These are presented in Figure 1 below.



The outer ear consists of two major parts: the fleshy, externally visible part of the ear (the pinna), and the ear canal, which is an air filled passageway that ends at the ear drum. The outer ear serves four main functions: it acts as a resonator for tones around 3000-4000 Hz., it protects the eardrum, it makes possible consistent temperature and humidity in the middle ear and it collects high frequencies. Were the eardrum located directly on the surface of the head, these functions would not be possible.

The *middle ear* connects the ear drum to the inner ear by means of the auditory ossicles (three small bones): the malleus (hammer), the incus (anvil) and the stapes (stirrup). When the ear drum is set in motion by sound waves which travel through the ear canal, this motion is picked up by the malleus and transmitted to the incus. The incus further transmits the motion to the stapes. The stapes in turn moves in and out of the oval window, which is the entrance to the inner ear. Figure 2 below presents a cross sectional illustration of the middle ear.

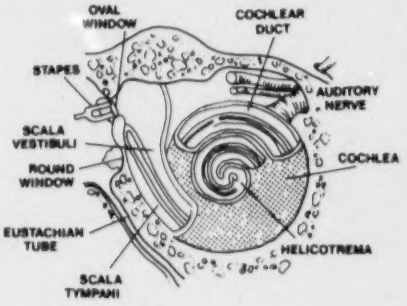


The middle ear serves two main functions. The first is to increase, or amplify, the pressure of the sound waves at the oval window, so that the inner ear receives an increased amount of acoustical energy. The way in which the middle ear does this is by acting as a kind of "funnel" between the eardrum and the oval window. The surface area of the eardrum is about 25 times larger than the surface area of the oval window, so that the pressure received at the eardrum and transmitted through the ossicles is now applied by the stapes to a much smaller area. The result is that the pressure applied to the oval window is about 25dB greater than it would be without the middle ear, i.e., if sound traveled directly from the canal to the oval window. This amplification makes it possible to hear sounds which would otherwise not be heard.

The second function of the middle ear is to guard against damage to the inner ear from extremely loud sounds. Two small muscles work to achieve this protective function. In response to loud sounds, one muscle pulls in the eardrum, while the second pulls the stapes back from the oval window. As a consequence, the middle ear becomes a less effective sound transmitter. Additionally, muscle contractions can change the normal axis of rotation of the stapes, which will also decrease the pressure variations reaching the inner ear through the oval window. This response is reflexive, but is not instantaneous. Therefore, in the time it takes this protective mechanism to go into effect, abrupt, intense sounds can still cause permanent damage to the inner ear. Drugs can also affect the functioning of these reflexes, so that for example, an individual taking certain medications for seizures (phenobarbytol, dilantin) may not automatically have these responses. Conductive hearing losses can also obliterate the reflex action (although the conductive component itself acts as a sort of protective mechanism). Furthermore, certain degrees of sensorineural loss will render the reflex impossible to measure. The presence or absence of these reflexes can be determined using impedance audiometry and is typically one measure in a battery of assessments made by a clinical audiologist (see Section III below).

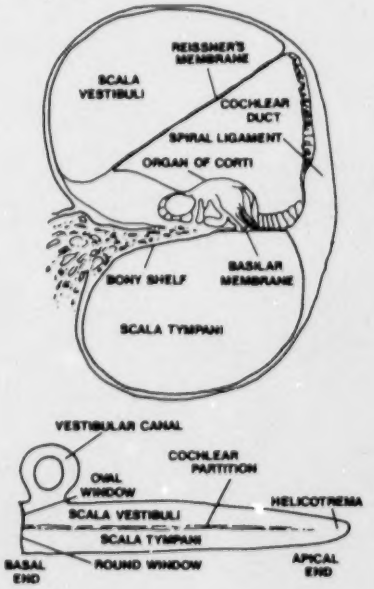
The last aspect of middle ear function concerns the eustachian tubes, which run between the middle ears and the nasopharynx. The function of the eustachian tubes is to provide a link between the middle ear and outside air so that the pressure inside and outside the middle ear cavity can be equalized. This is normally accomplished by swallowing, which allows the Eustachian tube to open momentarily. If this were not the case, unequal pressures inside and outside the middle ear cavity might bend, deform, or possibly rupture the eardrum.

A diagram of the inner ear is presented in Figure 3.



The major structure in the inner ear is the cochlea, which is coiled like a snail shell. There are some 30,000 nerve cells in the cochlea. It is within the cochlea that mechanical vibrations received at the oval window are transformed into nerve impulses which travel along the auditory nerve to the brain.

A full discussion of the construction and functioning of the cochlea is too lengthy for purposes of this manual, and the reader is referred to Denes and Pinson (1963) for detailed explanations. However, Figure 4 presents a cross section and a view of the cochlea as it would appear if it were unrolled.



Coursing through the center of the cochlea is the basilar membrane. The basilar membrane movement accounts for the cochlea's reaction to activity at the oval window.

Inside the Organ of Corti are hair (nerve)

cells. One end of each cell rests on the basilar membrane. When the membrane vibrates, the hair cells are bent.

Nerve fibers from the auditory nerve extend into the Organ of Corti and come to rest very near the hair cells. These nerve fibers then carry pulses to the brain. For most frequencies, pitch is determined by *where* on the basilar membrane the stimulation occurs. If high frequencies are received, the vibration is strongest in the part of the basilar membrane nearest the oval window, where the membrane is stiffest. If lower frequencies are received, the vibration is strongest in the wider and more flexible end of the membrane. *Intensity* is determined by how many hair cells are stimulated. The more intense sound, the more hair cells are stimulated, and the faster they fire. Thus, stimulation from the middle ear is converted into patterns of vibration on the basilar membrane which are then translated by the Organ of Corti into signals that can be electrically transmitted along tne auditory nerve.

Common Causes of Hearing Loss and Deafness

Hearing losses are typically categorized as either conductive, sensorineural, mixed or central auditory disorders.

Conductive impairments are losses resulting from interference in the pathway from the ear canal to the inner ear. The inner ear functioning is intact, but the air conduction pathway is in some way defective. The result is a loss of air conducted sounds, although the individual can typically hear sounds conducted directly to the inner ear through an audiological procedure known as bone conduction testing. A majority of losses which are conductive can be corrected through medical treatment or surgery (Northern and Downs, 1978).

Sensorineural impairments are losses involving damage to the inner ear and/or the auditory nerve. In this case, physical examination of the outer ear may reveal an external canal and ear drum which look normal, since the loss is due to deficits beyond the ear drum. Sensorineural losses are usually irreversible.

Mixed impairments are those in which both the conductive and sensorineural systems are deficient. The mixed loss will improve only as much as the conductive loss is ameliorated, and will typically not return to normal hearing ranges (Northern and Downs, 1978).

Central Auditory Disorders. The auditory system is considered in terms of the peripheral mechanism which extends from the outer ear to the ending of the acoustic nerve in the brain stem, and the central auditory system, which involves the neurons leading from the brain stem into specific areas of the brain (Goldstein et. al, 1972). Lesions in the peripheral system result in decreased auditory acuity in the form of conductive, mixed, or sensorineural losses. Lesions in the central auditory system affect the coding and analysis of auditory information, and are independent of deficits in the peripheral system. Thus, an individual may have normal auditory sensitivity, but may be unable to respond meaningfully to sound due to central organic dysfunctions. Differential diagnosis of central disorders and peripheral impairments can be a complex problem, particularly with severely handicapped students. Amelioration of central disorders is not accomplished through hearing aids but through language therapy and educational interventions.

Some possible causes of sensorineural and conductive losses are briefly described in Tables 1 and 2, but this list is by no means exhaustive.

In addition to conditions described in Tables 1 and 2, a teacher of severely handicapped students should be aware of the need for prompt referral to a medical specialist if any of the following conditions are observed:

Foreign objects in the ear canal, including toys, food, pebbles, crayons, etc.

Aural discharge. Discharge from the ears may be clear, cloudy, or bloody, each indicating different possible causes and all requiring prompt medical attention.

Extreme sensitivity of the pinna. If touching a student's ear causes wincing, cringing, or other overt signs of discomfort, otitis externa, an inflamation of the skin in the external canal, may be pressent. This condition often occurs in hearing aid users, where ear molds may block adequate ventilation of the skin in the canal. If a student is unable to insert and remove his own aids, the teacher should be alert to any redness and apparent tenderness in the canal when putting aids on or off. If sensitivity is observed, an otologist should be consulted.

Table I: POSSIBLE CAUSES OF SENSORINEURAL LOSS

ANTENATAL and NEONATAL	
Maternal Infections (e.g.),	
Rubella (German Measles) Congenital syphilis Asian flu Cytomegalic Inclusion Disease	A number of maternal bacterial and viral diseases may result in varying degrees of sensorineural loss. Effects may vary, mainly depending upon when during pregnancy the infection is contracted. Some viruses, such as the cytomegalovirus may be asymptomatic in the mother but can be passed on to the infant with severe effects upon the central nervous system. These viruses may result solely in hearing loss or can cause multiple disorders.
Rh Incompatibility	This condition results in the destruction of Rh positive blood cells in the fetus and may cause a number of complications in the newborn, including retardation, cerebral palsy, and epilepsy. Associated hearing loss may range from mild to profound.
Maternal Ingestion of Ototoxic Drugs (e.g.),	Ototoxic drugs are those which may permanently injure, destroy or retard development of the inner ear, including hair cell damage in the cochlea and absence of auditory nerves. The result is sensorineural loss; however, ingestion of such drugs during the first trimester of pregnancy may also contribute to conductive losses due to malformation of the auditory ossicles. Ototoxic drugs may also produce a number of other congenital abnormalities.
Salicytes Quinine Streptomycin "Mycin" Drugs	
Genetic Disorders (e.g.),	These genetic disorders typically result in failure of some portion of the inner ear to reach full development. In the case of the syndromes listed here, for example, membranes within the cochlea do not reach full development and degeneration of the Organ of Corti may be observed.
Waardenburg's Syndrome Jervel and Lange-Nielsen Disease Usher's Syndrome	
ACQUIRED	
Bacterial and Viral Diseases (e.g.),	Sensorineural losses ranging from mild to profound may occur because of direct infiltration of the bacteria or virus to the inner ear. Effects may include destruction of the Organ of Corti, destruction of neural pathways, or damage to other parts of the inner ear.
Meningitis Measles Mumps Chicken Pox	
Ingestion of Ototoxic Drugs (e.g.),	Considerable individual variability exists in susceptibility to the ototoxic effects of these drugs. As in the case of maternal ingestion, these drugs affect hearing by destruction of the hair cells in the cochlea.
Kanamycin Neomycin Gentamycin	
Head Trauma	Hearing loss due to a concussion may show recovery; however, hearing loss caused by a fracture line through the cochlea, which may result in total deafness, is irreversible.
Noise Induced	Although susceptibility is apparently highly individual, exposure to intense sounds can damage the inner ear and cause hearing loss which may be either temporary or permanent. Firecrackers, noisy machinery, and toy firearms are examples of sounds which may result in sensorineural loss, typically for sounds in the high frequency range.
Acoustic Neuroma	This condition refers to tumors of the auditory nerve. It has rarely been reported in children.

TABLE 2: POSSIBLE CAUSES OF CONDUCTIVE LOSS

ANTENATAL and NEONATAL	
Genetic Disorders (e.g.), **Pierre-Robin Syndrome** **Treacher Collins Syndrome** **Apert's Syndrome** **Klippel-Feil Syndrome** **Crouzon's Disease**	**Conductive losses due to genetic disorders typically involve middle ear anomalies such as deformation in the auditory ossicles. Many of these deformities are surgically correctable.**
Cleft Lip and Palate	**The incidence of recurring middle ear diseases in children with cleft palate is quite high. Middle ear disease such as otitis media (described below) affects the air conduction pathway and may cause conductive losses. Because the associated middle ear disease may have variable effects upon hearing, the hearing of individuals with cleft palate requires regular monitoring.**
ACQUIRED	
Tympanic Membrane Perforation	**A perforation of the tympanic membrane may result in a conductive loss. Traumas such as blows to the head, or middle ear disease, may cause the perforation. The degree of loss is dependent upon the size and location of the perforation(s). Perforations occasionally heal spontaneously, but often require medical intervention. In all instances, a physician should be alerted.**
Otitis Media	**Otitis media is a pathological condition of the middle ear and is differentiated into several types. *Serous* otitis media occurs when the eustachian tube is blocked, causing negative pressure and the appearance of fluid in the middle ear cavity. *Supprative* otitis media may be accompanied by sudden ear pain; the pain may subside upon the rupture of the tympanic membrane. In this condition, the fluid in the middle ear cavity is infected. *Chronic* otitis media is a recurrent disease in which middle ear tissues may undergo a repeated cycle of deterioration, healing, and scarring. Discharge from the ear can occur in some states of otitis media. Medical intervention may involve inserting tubes into the ear canal to facilitate drainage and ventilation. The presence of such tubes precludes the use of any hearing aids requiring closed ear molds, as such molds fill the pinna and block ventilation.**
Cholesteatoma	**Cholesteatoma occurs when skin from the ear canal grows into the middle ear cavity or mastoid through a perforation in the tympanic membrane. The cholesteatoma is susceptible to bacteria and moisture which may cause erosion of bone tissue and other complications.**
Impacted Cerumen	**Cerumen is ear wax, which may bo either wet (yellow to dark brown in color) or dry (powdery whitish scales). Typically, ears are self cleaning, in that the build up of cerumen migrates outward into the outer ear canal, where it can be easily wiped away with a washcloth. If too much accumulates in the canal, however, it can cause hearing loss. Impacted cerumen must always be removed by a physician, as improper attempts may result in damage to the ear canal and/or ear drum. Similarly, removal of foreign objects from the ear canal requires a medical specialist.**
Head Trauma	**Skull fractures may disrupt the ossicular chain, resulting in a conductive hearing loss; blows to the head may also result in perforation of the tympanic membrane as discussed above.**

II. Teacher Based Informal Assessment

Rationale

This chapter describes procedures to evaluate responses to sound that a teacher of severely handicapped and/or deaf/blind students can perform in the classroom. These procedures involve presenting various auditory stimuli to the student and watching for reliable changes in behavior. The goal of the procedures is *not* to replace formal audiological assessment by an audiologist or formal medical evaluation by an otologist. If there is question as to the status of a student's hearing, the teacher's first step should be to seek both medical and audiological evaluations.

However, there are at least two reasons why it is important for teachers to be familiar with informal procedures for assessing responses to sound:

1. Formal audiometric test results often do not provide information about how well a student uses the hearing he does have. As Kukla and Connolly (1978) point out, an audiogram can reveal an individual's sensitivity to sound at different frequencies, but it does not reveal how an individual uses his hearing. A student's hearing mechanisms may be intact, but in the classroom environment he may function as if he has no hearing at all. For the student whose formal evaluation indicates no loss, or only a mild loss, the teacher can use informal assessment procedures to evaluate the student's *functional use* of his hearing in the classroom. If the student does not use his hearing functionally, instructional programs may be developed to improve skills such as localizing to sounds or discriminating among sounds.

2. A second reason for the inclusion of teacher based assessment strategies is the determination of particular responses and sound cues that can be used in training individual students for formal audiological assessment. (See the programs in Section III) Many severely multiply handicapped students have only limited and/or idiosyncratic response modes available to them due to extreme physical and/or mental disabilities. By carefully observing responses to auditory stimuli, the teacher may be able to identify a reliable response for use in programs designed to prepare a student for formal testing by an audiologist. Careful observation of a student's responses to a variety of sound stimuli may also reveal which particular auditory cues reliably produce a response. These cues can be considered as initial auditory stimuli in a number of programs discussed later in this manual (see Sections III and V).

Developmental Sequence of Auditory Functioning

The validity of "normal" developmental sequences of auditory behavior for severely handicapped individuals remains to be demonstrated, and teachers should not necessarily expect to observe precisely this sequence in every student. However, the developmental sequence of behavioral responses to sound is discussed here to provide the reader with a general framework for understanding auditory functioning. More detailed reports can be found in Cox and Lloyd (1976), Northern and Downs (1978) and Kukla and Connolly (1978).

From birth through the age of approximately 3 months, the neonate's responses to sound are largely reflexive in nature and may include the following: a startle or Moro response; widening, shifting or blinking of the eyes; crying; jerking; frowning; or an abrupt increase or decrease in activities such as sucking. While the newborn's most noticeable early responses are typically to gross sounds such as a door slamming or a telephone ring (Kukla and Connolly, 1978) an increasing body of evidence suggests that speech may be the most effective stimulus for obtaining a response in newborns, infants and children (Northern and Downs, 1978; Eisenberg, 1976; Franklin, 1977). In particular, by the time the typical infant reaches three months of age, many reflexive responses to loud environmental sounds may be inhibited because the infant has learned that these sounds are irrelevant to him, i.e., their occurrence is rarely followed by predictable meaningful experiences. Hence, he learns to ignore them.

Also critical in evaluating the newborn's responsiveness to sound stimuli is the infant's state when the auditory stimulus is presented (Bench, 1971). Thus, for a baby in an active pre-stimulus state, the stimulus may result in activity decrease; for the same baby in a passive, quiet pre-stimulus state, the stimulus may result in activity increase.

Subsequent to the level at which responses to sound are primarily reflexive in nature, some authors, such as Kukla and Connolly (1978), have proposed a level of response which involves attention and/or alerting to sound as indicated by facial expressions, inclination of the head, laughing at familiar sounds, or searching for the sound. According to these authors, familiar sounds (familiar toys, speech, etc.) are most effective in eliciting early attending responses to sound. These attentional responses to sound in turn form the initial step in sound localization. Localization skills typically begin to develop by the time the infant reaches three months of age. For sounds presented at a distance of 12-36 inches from each ear, Table 3 describes the typical localization sequence (Northern and Downs, 1978; Cox and Lloyd, 1976).

Available data also suggest that once the infant reaches 3 months of age, meaningful sounds such as crinkling papers, a spoon stirred in a cup, speech, etc., may be more likely to evoke responses than meaningless sounds such as pure tones (Ewing and Ewing, 1944).

In addition to the above behaviors, the infant is also developing a number of other auditory skills described by Kukla and Connolly (1978). These include auditory *discrimination* skills, or the ability to differentiate among sounds (are sounds the

AGE	BEHAVIOR
4-6 months	Child turns directly to sound presented laterally on plane level with the ear.
7-10 months	Child turns head to side, then downwards to identify sound presented laterally below the ear.
9-11 months	Child turns directly to sounds presented laterally in a plane below the ear.
11-14 months	Child turns head to side, then upwards to identify sound presented laterally above the ear.
13-18 months	Child turns directly to sounds presented laterally in a plane above the ear.
19-24 months	Child directly localizes to any angle. However, sounds presented directly above or behind the head may not be correctly localized until later ages.

TABLE 3

same or not the same, based on spectral characteristics, length, intensity, rhythm, pitch, etc.); and auditory *recognition* skills, or the ability to obtain meaning from sounds and/or to attach meaning to sounds (following simple directions, identifying objects on the basis of their speech labels, etc.). Thus, in addition to the development of localization skills during the first two years of life, auditory discrimination skills are reflected in vocal imitation, and differential responses to different sound sources. The child may babble in response to human voices, but cry in response to a sudden thunderclap, indicating that he discrimates the two sounds as different from one another. By 18 months of age, initial recognition skills are also developed. The child shows understanding (reception) of some words by appropriate behavior such as looking at familiar objects upon request, and begins to use expressively (expression or production) a small vocabulary of meaningful words. From this point on, normal auditory functioning involves the development of increasingly sophisticatd linguistic skills, discussion of which is beyond this manual's scope.

General Considerations

In evaluating an individual's response to sounds, a number of factors come into consideration, including individual characteristics of the student being evaluated, general setting variables, properties of the auditory stimuli used in evaluation, and dimensions of possible response modes, particularly with severely multiply handicapped students. These factors are discussed below and should be thoughtfully considered for each individual student undergoing evaluation.

Student characteristics. A major consideration is *appropriate positioning* of a student before presenting assessment items. Ambulatory students and/or students capable of independent sitting should be seated at a table or desk. For students with severe physical disabilities (e.g., extreme spastic quadriplegia or athetosis, scoliosis, hypotonia, etc.) the first step is consultation with a physical or occupational therapist. Explain to the therapist the kinds of responses you will be watching for, such as searching or blinking of the eyes, head turns, and changes in activity level. Determine a position which normalizes muscle tone and facilitates whatever voluntary movement the student may have, but which will also still allow you to present the sound stimulus at various locations to the side and back of the student, and will allow you to observe potential responses (e.g., eye movements will be difficult to observe closely if the student is in a side lying position). Also confirm whether or not the student shows abnormal reflex activity, such as asymmetrial tonic neck reflex, to a particular side, as a localization response to that side may stimulate undesirable abnormal motor patterns.

In working with newborns and infants, debate continues as to whether the infant should display a high or low state of activity level when the auditory stimuli are introduced. Several authors (Bench, 1971; Taylor and Mencher, 1972) report that a state of light sleep predisposes the best response to sound in neonates, suggesting that a low activity state may yield best responses. If the student you are evaluating will remain seated and cooperative for a 15-20 minute session without objects to manipulate or a simple task to perform, the assessment can be performed in this passive activity state. However, many severely handicapped students will not remain attentive if required to sit passively for 15-20 minutes, and may instead engage in self-stimulatory/stereotypic behaviors or attempt to leave the session. For these students, a toy or fine motor task may be presented for manipulation during the test session. Caution should be taken not to use a task which is so highly reinforcing that the student no longer attends to the teacher, and the teacher should be prepared to frequently introduce new and varied objects.

Arguments also can be made for evaluating responses when a student is in a high state of activity and is displaying repetitive and or stereotypic behavior patterns. Cessation of activity (often of repetitive activities such as rocking) may also provide a reliable form of responses.

Setting: In general, our recommendation is to perform the functional assessment in the context of the normal *classroom environment.* However, it should be noted that the ambient noise level (intensity level of general background noise) may range from 58 to 68 dB SPL in a typical classroom. This means that an auditory testing stimulus of 65 dB SPL or lower may not be discriminated in the context of normal classroom noise levels. (Intensity characteristics of the stimuli used in testing are discussed in detail below.)

Auditory Stimuli: Several testing stimuli should be selected from each of three categories: speech, environmental sounds, and noise makers. Examples of each are presented in Table 4. Use of broad spectrum sounds (sounds which include a wide range of frequencies) is recommended, as it will increase the likelihood of obtaining responses. A student with a high frequency loss, for example, may still respond to low frequency sounds and can respond to the low frequency components of a broad spectrum sound. Since the goal of this assessment is not to obtain hearing thresholds at differing frequencies, high and low frequency sounds need not be presented separately, as they are during formal evaluations. Items in Table 4 are some examples of broad spectrum sounds.

SPEECH	ENVIRONMENTAL	NOISEMAKERS
Child's name	Spoon in cup	Drum
Name of favorite object	Water pouring	Maracas
Clucking/Babbling	Candy/cookie wrapper opening	Toys: Pound-A-Round from Child Guidance
	Door Slam	Chatter Telephone from Fisher Price

Table 4

Because the available data discussed above suggest that better responding may be obtained with use of meaningful auditory stimuli, attempts should be made to select sounds and words with which the student has had experience (i.e., a typewriter produces meaningful sounds, but is probably unfamiliar to most severely handicapped students).

Once sounds have been selected, the ideal procedure is to make a tape for use during testing. An inexpensive cassette recorder is adequate for this purpose. A simple procedure is to make a tape of 5-10 minutes of continuous sounds, alternating randomly among the sound stimuli and activating each stimulus for about 5 seconds.

Once the tape has been made, calibration by an audiologist is desirable. Calibration involves measuring the intensity level of the sound with a sound level meter under conditions specifying the distance from the student. By setting the volume control on the recorder at specified settings, it should be possible to determine the intensity levels reaching the student, i.e., at one setting, most sounds are 70-80 dB; at another setting, most fall within 50-60 dB range. The tape can then be used by allowing it to run continuously but silently during the test session and activating the volume control to a preset level to produce sound stimuli during the assessment session.

If audiological services and/or tape recorders are not available to you, Kukla and Connolly (1978) have presented information on the approximate intensity levels of various sound stimuli when activated according to specific directions (i.e., drop 1" wooden cube in coffee can at 3-4 feet from child). While less reliable than a calibrated tape, this information is a preferable alternative to not evaluating a student's responses at all.

After the test stimuli have been calibrated, the following procedure is recommended. Select an intensity level (e.g., 70-80dB SPL), and present all stimuli for the session at this level. To assess a different intensity level (e.g., 50-60dB) repeat the entire session at a different time using the less intense sound stimuli. Again, the goal of this process is not to determine hearing thresholds. However, this process may enable you to identify a general intensity range in which the child appears to respond most frequently.

Within the test session itself, the sound stimuli should be presented on a random basis to the left or right side. Length of intertrial intervals should also be varied, so that stimuli are not presented at predictable, regular intervals. A sample data sheet is included below.

Responses: As indicated in the review of the development of normal auditory behaviors, responses to sound stimuli may take a variety of forms. With severely multiply handicapped students, reliable responses may be particularly difficult to observe due to either lack of extensive voluntary movement, or to the presence of excess movement such as spasms, tremors, or nystagmus, which are not readily discriminable from other responses the student might make.

For this reason, careful observation of the student's *prestimulus state* is mandatory. If the student demonstrates a great deal of random involuntary movement, presentation of the auditory stimulus must be carefully timed. Initiation of the auditory stimulus during a moment when the student is relatively quiet or still may make it easier to observe increases in activity level in response to the sound cue. Initiation of the auditory stimulus during a high activity state may make cessation responses easier to observe.

In order to facilitate discrimination of responses from other random movement patterns, observe the student for 3-5 minutes before beginning the evaluation so that you are familiar with any habitual motor patterns the child may demonstrate, such as repeated rolling of the eyes, head weaving, vocalization patterns, etc. Familiarity with the student's typical movement patterns will enable you to vary timing of the presentation of the auditory stimuli. On some trials, activate the stimulus during high activity and watch for cessation responses. On other trials, waiting for a moment when the student is relatively still or quiet will make more subtle responses and/or increases in activity level easier to observe.

Possible responses are detailed below. Responses should occur within 5 seconds of the sound stimulus. If possible, it is suggested that the teacher try the assessment procedures with young, non-handicapped students in order to become familiar with the responses as presented by a student who does hear them.

Changes in eyes: This response may involve an eye-widening, "what is it?" response; eye searching behavior, in which eyes move to seek the sound source (the eyes will *not* necessarily move in the correct direction); and blinking or repeated winking of the eyes.

Searching/Localization Responses: The student may seek the sound source by turning his head, reaching his arm, or turning his entire trunk in the direction of the sound source.

Changes in activity level: Dependent upon the child's pre-stimulus state he may show either a decrease or an increase in overall activity level. A quieting response may involve cessation of ongoing vocalizations and/or a brief, momentary cessation of any other ongoing motor activity. Increases in activity include the initiation of any motor behaviors absent in the prestimulus state or the continuation of a prestimulus activity but at a faster and/or more intense rate.

Jerk/Startle Response: A sudden involuntary movement of the entire body; the limbs may abruptly extend either outward away from the body (extension) or inward toward the body (flexion).

Changes in affect: These changes from the pre-stimulus state may include distinct positive changes in the form of a smile or laughter; or negative changes in the form of a frown in which the brows are wrinkled, or a crying/whimpering response accompanied by a negative expression.

Volcalization Responses: This response entails distinct grunts, babbling responses, changes in breathing or sucking patterns, or other speech behavior.

No Change: This response category means the child remains in his prestimulus state. If the child was inactive before the auditory stimulus, he remains inactive; if he displayed activity before the auditory stimulus, the activity continues with no changes in rate or intensity. No change does *not* mean that the student did not hear. It merely means that no change in behavior was observed.

Actual Assessment Procedures

Actual procedures to follow during the assessment session are listed on the following page. A sample data sheet follows, and the chapter concludes with a discussion of informal evaluation results.

Setting: Quiet area of the classroom. The child should be seated at a desk or table, or appropriately positioned in light of factors discussed above.

Materials: Pre-selected and calibrated auditory stimuli; fine motor task if deemed appropriate for the student; data sheets with randomized R/L position filled in.

Reinforcement: Social and/or tangible reinforcement may be delivered on a non-contingent basis to maintain the student's cooperation.

Procedures: One adult (a test assistant) should be seated directly *behind* the student with a copy of the data sheet and the auditory stimuli easily at hand. The second adult (preferably the teacher or someone familiar with the student) should be seated directly in front of the student. The teacher will observe the student, cue the assistant when to activate the auditory stimulus, and record the student's response. The steps are presented below.

1. Before presenting the actual assess-

INFORMAL AUDITORY ASSESSMENT

Name _____ **Speech Stimuli** _____

Date _____ **Environmental Stimuli** _____

Approx. d_B level _____ **Noisemakers** _____

Aided or Unaided Test _____ **Most recent audiological** _____

	R/L	STIM	Eyes	Search	Activity Increase	Activity Decrease	Smile/ Laugh	Frown/ Cry	Vocal	Startle	No Change	Other (Describe)
1												
2												
3												
4												
5												
6												
7												
8												
9												
10												

TOTALS _____

Total trials on which responses were observed: (X/10)_____ **Total responses to Right** _____

Total responses to speech _____ **Left** _____

Total responses to environmental sounds _____

Total responses to noisemakers _____

Most frequent response type: _____

Comments:

ment items, observe the student for 3-5 minutes to become familiar with any motor activity patterns.

2. Test assistant: Position the stimulus 2-3 inches to the right or left of the student's posterior midline, and the specified distance needed for the correct intensity. Follow the positioning on the data sheet.

3. Teacher: Wait 3-5 seconds after the positioning of the stimulus to avoid creating visual cues. Then observe the student. When you judge him to be in an appropriate state, cue the assistant to activate the stimulus.

4. Assistant: On cue, activate the stimulus for 2-3 continuous seconds.

5. Teacher: Observe the student and record 1) the type of stimulus, and 2) *all* of the responses you see on the data sheet.

If, immediately after a given trial, it is your judgement that the cue was poorly timed (for example, the stimulus coincided with an involuntary tremor, spasm, etc.) do not record the data and re-present the trial.

Criteria: If the student responds to 80% or more of the trials on the first session, further assessment sessions are not recommended. If responses are inconsistent, at least 2 separate sessions for each dB level are recommended, or as many sessions as you need to feel confident of your results.

Assessment Results

Types of information: If the assessment is repeated several times with a particular child, several types of data can be gathered, including 1) overall presence or absence of responses to sound; 2) identification of a consistent response type across sessions (i.e., the student most frequently responds with an eye-leading reflex); 3) identification of particular auditory stimuli to which the student consistently responds (i.e., student responded to 75% of the speech stimuli, but not at all to environmental sounds); 4) identification of a consistent side to which the student responds (i.e., student orieted to 60% of stimuli presented to left side and 10% of stimuli presented to right side); and 5) identification of approximate intensity levels at which responses are consistently observed.

Applications and educational implications: At the beginning of this chapter, a number of reasons for performing this assessment were discussed, including evaluation of a student's functional use of his hearing and identification of preferred response modes and/or auditory stimuli for use in auditory training programs. Regardless of the reasons which motivated the informal evaluation, it is *not* a replacement for evaluation by an audiologist, and teachers should *not* make the inference that a child does or does not hear based upon this assessment. With practice and careful observation, teachers *may* be able to identify conditions under which a particular child demonstrates a consistent reliable response to a sound stimulus. However, the inference that the presence or absence of such responses means the child can or cannot hear is one that only a trained audiologist can make. The first step in utilizing your results, therefore, is to share them with a clinical audiologist. Explain why you performed the assessment in the first place. For example, the child may have no documented hearing loss, but does not respond to verbal cues in the classroom, and you are looking for a response to use in a functional localization program. If your objective in administering the assessment was to identify either a consistent response mode or a reliable auditory stimulus and you have been able to do so, use this information in carrying out instructional programs in Section III which are appropriate for the needs of your students. Also, share this information with the audiologist, as it may be helpful during formal audiologic test sessions.

Project development data. Project personnel evaluated a total of 17 severely handicapped students using these procedures. The average inter-rater reliability coefficient for two classroom personnel watching one student was .74. The range of reliability scores was .35 to 1.00, with a median of .75. As these data indicate, there was considerable variation in realiability measures, even after repeated experience using the assessment. Project personnel who worked with this procedure generally expressed a lack of confidence in understanding implications of the assessment, even in instances of high reliability of measurement. Thus, even when two persons were readily able to agree that a response had taken place, it was impossible to comment on what this response meant.

For this reason, emphasis is placed not upon perfecting teacher assessment but upon developing classroom programs that can facilitate formal audiological evaluation. Such programs are detailed in Section III. The procedures described here should be carried out only 1) to identify responses/stimuli for use in programs in Section III; 2) to provide supplemental data to support a teacher's concern about the status of a student's hearing; and 3) to indicate a student's functional use of his hearing if it is known to be within normal limits. If a student requires an audiological evaluation, application of one of the programs in Section III represents the most beneficial use of instructional time.

III. Formal Audiologic Assessment

Common Audiometric Procedures

The aim of formal audiologic evaluation of a severely handicapped student whose hearing status is unknown is to obtain several types of information, including:

1) the degree of loss in decibels;
2) frequencies at which the loss is present;
3) the type of loss (conductive, sensorineural, mixed, central);
4) inter-aural differences (differences in the hearing status in each ear);
5) implications of the loss for the student's educational, linguistic, and social development.

All of this information is necessary for the audiologist to make recommendations regarding appropriate amplification. Conductive losses, for example, may be medically correctable. Differential hearing in the two ears has direct implications for the model and number of hearing aids recommended, while the degree and type of loss may have direct implications for both the type of aid and the type of ear mold that is selected. Factors such as these make it extremely important to gather reliable data during formal audiometric evaluations. Two types of test procedures are typically used to obtain this information: behavioral measures, which use overt behavioral responses to auditory stimuli; and objective measures, which involve physiologic responses to auditory stimuli.

Behavioral Test Procedures

Audiologists have developed a variety of behavioral procedures for use with infants, young children, and/or difficult to test persons. These procedures are briefly described below:

Behavioral Observation Audiometry (BOA). In BOA procedures, the student is placed in a soundproofed test booth. Using calibrated equipment, the audiologist presents a variety of controlled sound stimuli (i.e., speech, warbled tones, pure tones, etc.) on an intermittent basis. The audiologist watches the child and observes any changes in behavior in response to the presentation of the acoustic stimuli. Responses may include any of the behaviors discussed in Section II, such as abrupt cessation or increases in activity level, startle responses, an eye leading reflex, etc. Because of the high probability that changes in behavior may coincide with presentation of the sound stimuli on a random or chance basis, it is extremely important that the observed behavioral responses are stable across several presentations of the stimulus.

BOA has been frequently recommended for assessing multi-handicapped children (cf. Thompson & Weber, 1974). However, low interobserver reliability of measurement has been reported using this procedure, as discussed previously. In addition, habituation to sound stimuli may occur during BOA, making accurate assessment difficult. While it is sometimes the only procedure that can be used with a particular child, some of the other procedures below may yield more reliable results.

Stimulus Control Procedures. All of the following procedures utilize differential reinforcement procedures to bring a behavioral response under stimulus control of an auditory stimulus. The student learns to perform a certain behavior in response to an auditory stimulus, and not to perform the behavior in the absence of the auditory stimulus. Once he reliably performs the behavior in response to a sound, the frequency and intensity characteristics of the auditory stimuli are systematically varied. Presumably, when the child ceases to respond, he no longer hears the acoustical stimuli. Each of these procedures establishes stimulus control in a slightly different way, as described below.

1)**Visual Reinforcement Audiometry (VRA).** Visually reinforced procedures typically use light sources (blinking lights, "sparkler" toys) as reinforcement. In the most common form of VRA, first discussed as COR (conditioned orientation reflex) by Suzuki and Ogiba (1961), the child is seated between two light sources in front of him; one at an angle of approximately 75 degrees to the left, and one approximately 75 degrees to the right. Initially, the visual and auditory stimuli are presented simultaneously. Ideally, the initial auditory stimulus is of sufficient intensity to have evoked some prior response on the part of the student. If the student has displayed no prior response to any sound stimuli, a maximum level auditory cue may be needed during initial training. The sound is delivered to the right ear as the light source on the right side is flashed, and the child turns his head to the right to see the light source. Once the child reliably turns his head toward the paired visual and auditory stimulus, the visual stimulus is shifted in time so that it is flashed on just *after* a head turn occurs to the auditory signal. Hence, it serves as reinforcement for the head turn response to the auditory cue. When the child consistently turns to the sound cue using the visual stimulus as reinforcement, the audiologist can begin to systematically vary the acoustic stimuli.

Since the initial report, visual reinforcement procedures have been modified and no longer require accurate localization responses. Any observable, repeatable response, such as an eye blink, for example, may be used (Liden & Kankkonen, 1961). Although it is a frequently used procedure, the success of VRA is dependent upon rapid conditioning of the desired response to the paired auditory/light stimulus. If this conditioning does not occur within the test sessions, the procedure is not successful. The procedure is used for testing neurologically intact 1-3 year olds.

2)**Play Audiometry.** In play audiometry, the child is taught to perform a specific motor "play" response such as dropping a block into a bucket, stacking rings on a peg, etc., only when she hears an auditory stimulus. This procedure is typically used for testing neurologically intact children between three and five years old, and is based on the premise that the play response is fun and reinforcing for child. Hence, attention and cooperation can be easily maintained. A number of specific procedures have been developed for adapting play audiometry for use with difficult to test persons and they are discussed in detail in Lloyd (1966). As in VRA procedures, use of play audiometry during formal audiometric assessment is dependent upon relatively rapid conditioning during the test session. The child must rapidly acquire the discrimination of making the play response only in the presence of an auditory cue. The procedure differs from VRA procedures, however, in that the reinforcement is presumed to be intrinsic to the play behavior, rather than using a visual display, and the motoric response requirements are generally more complex than those used in VRA procedures.

3) **Tangible Reinforcement Operant Conditioning Audiometry (TROCA).** (Lloyd, Spradlin, & Reid, 1968; Fulton, 1974). TROCA procedures involve no verbal instructions and were specifically designed for use with children and difficult to test persons. Through prompting and/or shaping techniques, the individual learns to make a simple motor response, i.e., pushing a button in the presence of an auditory signal. Initially, the child may push the button during or immediately after an auditory signal by chance. However, he is immediately reinforced with the delivery of edible and/or tangible reinforcement known to be highly motivating for him. Responses made in the absence of the auditory cue are not reinforced. The initial auditory stimulus (presented at sufficient intensity, as discussed above) is

systematically altered as the child comes under stimulus control of the auditory signal. Successful shaping of a response using TROCA procedures may involve hundreds of training trials and extensive time on the audiologist's part.

During an actual test session, an audiologist may use several of these procedures or she may combine procedures such as using tangible reinforcement in conjunction with play audiometry procedures, or visual reinforcement in conjunction with BOA. In general, however, the stimulus control procedures discussed above are dependent upon rapid conditioning to the test paradigm within the test session itself. Because such rapid conditioning is frequently unsuccessful with severely multiply handicapped persons, the programs at the end of this chapter have been developed for teachers to establish a reliable response to sound in the classroom before taking a student for formal evaluation. Their purpose, then, is to enhance the probability of obtaining valid test results during formal audiologic evaluation.

Objective Hearing Tests

In addition to the behavioral tests described above, formal evaluation may involve a number of objective hearing measures. Objective hearing tests measure involuntary responses to acoustical stimuli. They can be conducted without active participation on the part of the person being tested. A variety of objective tests are available, but only some of the most commonly used tests are discussed here.

Impedance Audiometry. Impedance Audiometry entails measurement of the functional capability of the peripheral portions of the auditory system to transmit sound to the inner ear. Three sub-tests are designed to evaluate the conduction of sound waves through the middle ear to the inner ear. The instrument used to obtain these measures is an electroacoustic bridge. This bridge consists of a headset with an ear phone for one ear, through which sound can be delivered, and a probe from which measurements are obtained from the other ear. The three subtests involved are the following:

1) **Tympanometry.** In this test, the mobility and intactness of the tympanic membrance (eardrum) are assessed. Excess stiffness or looseness in the eardrum may have a direct effect upon the transmission of sound waves to the middle ear. Results of this procedure are charted on a graph called a tympanogram. Basic tympanogram response curves have been identified which are typically associated with specific types of disorders in the peripheral hearing mechanism. Interpretation of the tympanogram is part of the audiologist's overall hearing assessment.

2) **Static compliance.** This test assesses the mobility of the middle ear system at rest. As with tympanometry, abnormal stiffness may be associated with various pathologies in the peripheral hearing mechanism. Interpretation of static compliance test results is limited, however, by the fact that normal results cover a very wide range.

3) **Acoustic reflex thresholds.** This test evaluates the hearing level at which the muscles in the middle ear contract, pulling in the ear drum and/or pulling and rotating the stapes away from the oval window. The effect of these muscle actions is to attenuate sounds that are too intense. However, the practical effect of this measurement is based on the fact that the reflex is loudness mediated. Therefore, the presence of a reflex indicates that the listener heard the sound.

Any one of the three impedance subtests alone does not yield a high degree of validity. However, when considered together as part of a full impedance battery, a substantial amount of diagnostic information can be obtained. Impedance testing is generally a rapid procedure that causes no discomfort. However, the individual must remain quiet for a brief testing period and must tolerate wearing the probe in her ear. Impedance testing is particularly useful in identification of conductive losses. Nevertheless, specific pure tone and speech thresholds (decibel levels at which the individual shows a response to these acoustic stimuli) cannot be determined with impedance testing. Therefore, results from this procedure can be most helpful only when considered in conjunction with data from behavioral tests such as those discussed above.

Brainstem Evoked Response Audiometry. Brain stem evoked audiometry (BSER) measures changes in electrical brain wave activity occurring in conjunction with the presentation of auditory stimuli. This type of audiometry involves preparing the child for an EEG by attaching electrodes to the scalp. If the child is not able to sit or lie motionless for 25-45 minutes, a general anesthetic may be required. Controlled auditory stimuli are then presented and brain wave activity is monitored by a signal averaging computer that sorts out which brain wave responses are temporally related to the auditory signals. BSER is not yet widely used because of the expense, time, and specialized training needed to interpret results, but it may be the only way to determine the intactness of the peripheral auditory system with difficult to test persons.

Bone Conduction Testing

Bone conduction testing measures sensitivity of the cochlea (inner ear). This test is performed by placing a small vibrating mechanism behind the ear which, when activated, sets the inner ear into motion. Comparison of thresholds obtained by air conduction testing (when sounds are delivered through the earphones) with those obtained by bone conduction testing signifies whether the loss is sensorineural, conductive, or mixed. However, the usefulness of bone conduction testing for severely handicapped students is sometimes limited because the task often requires the student to make a relatively complex auditory discrimination through a procedure known as masking. Bone conduction testing occurs in the context of behavioral test procedures discussed above.

Preparation for Formal Audiometric Assessment

If the student undergoing evaluation has not previously been seen by an audiologist, an initial visit can be facilitated if the teacher is prepared to provide the audiologist with several types of relevant information. If possible, it is suggested that the student's parent or primary caretaker also attend. In addition, medical evaluation by an otologist should precede the visit so the audiologist will have information about the medical/physical status of the student's ears. Finally, selection of a pediatric audiologist familiar with procedures for difficult to test individuals is recommended.

The audiologist may request several kinds of information, including a general medical history describing the student's overall medical status and a general educational history, describing the educational objectives and programs the student is working on in the classroom. Of particular relevance will be the student's auditory behavior in the classroom, including the auditory stimuli to which the student appears to respond, typical responses to sounds, etc. Bringing favorite toys, noisemakers, and reinforcers to the session my also be helpful to the audiologist.

Once a history has been obtained, the audiologist will utilize the behavioral and objective tests described above. Because successful behavioral test results can provide the most information about a student's actual ability to hear, and because these tests require successful conditioning to an auditory cue, two programs have been developed to teach a student a reliable response to sound for use during formal assessment.

Programs To Prepare Students for Formal Audiological Assessment

Two programs are presented here for use in preparing students for formal audiological testing. Both programs utilize a stimulus shift paradigm to establish a reliable response that can be used by an audiologist during a formal test session.

Stimulus shifts involve the transfer of stimulus control from one set of stimuli that control a response to a second set of stimuli that do not initially control behavior (Terrace, 1963; Touchette, 1971). Transferring stimulus control requires that the behavior initially be under stimulus control of a given stimulus. Stimulus control is then shifted to a neutral or non-controlling stimulus by pairing the controlling and non-controlling stimuli. Transfer of control occurs through gradual systematic stimulus change in which irrelevant stimulus components are faded out and/or relevant stimulus components intended to ultimately control the response are faded in (see Goetz, Baldwin, Gee and Sailor, 1982, for discussion). Stimuli have been systematically faded along numerous dimensions, including intensity (brightness or loudness) (Stoddard & Sidman, 1967), duration (Terrace 1963; Schreibman, 1975; Striefel, Wetherby, & Karlan, 1978) size or orientation of visual stimuli (Schreibman, 1975), and duration of the time interval between presentation of the controlling and non-controlling stimuli, in a procedure known as time delay (Touchette, 1971).

In both programs presented here, a motor response is first established to light stimulus. Light and sound are then paired as the discriminative stimulus for the motor response. The light stimulus is then systematically faded in intensity in order to shift the response to the auditory stimulus alone. This shift *may* or *may not* occur (for example, subsequent audiological assessment may indicate a profound bilateral hearing loss). If stimulus control is successfully transferred to an auditory stimulus, the audiologist now has a response to use in testing. Hopefully, he can now present auditory stimuli of varying frequencies and intensities, and the presence or absence of the response can provide information about what the student is hearing. If stimulus control is not succesfully transferred, however, the audiologist can still make use of a reliable response to light as part of formal evaluation procedures.

The program entitled "Teaching an Operant Motor Response" (OMR) teaches a motor response such as reaching for an object or performing a specific fine motor task (e.g., stacking rings) in response to the auditory cue. It is thus most comparable to play audiometry procedures discussed above. Experimental validation of the program is reported in Goetz, Gee, & Sailor (Ref. Note 1).

The program entitled "Visually Reinforced Localization" (VRL) teaches a head turn to the auditory cue (however, adaptation of the program for use with other responses is also discussed.) This program is thus analogous to COR and VRA procedures discussed above. Again, experimental validation of this program is reported in Goetz, Gee, & Sailor (Ref. Note 1).

The decision as to which program to use with which students depends on a number of student and program factors. In general, the VRL program has been selected for use with 1) students who have numerous motor disabilities that make a reach response difficult, or 2) students with extremely low vision (e.g., light perception limited to extremely intense light sources) who may not discriminate the light of an overhanging lamp used in the OMR program. The OMR program does require more active responding on the part of the student, and more natural consequences can be used as part of the training paradigm (e.g., the student can reach for a preferred object). If you are unsuccessful with one program, it may be helpful to try the other.

Before implementing one of these programs with a student, a number of general factors discussed below merit consideration:

Selection of Sound Stimuli: Does the student show reliable responses to particular sounds or categories of sounds (e.g., speech, noisemakers, environmental sounds)? Data from the student's informal auditory evaluation (Section II) may be particularly helpful here. If the student demonstrates consistent responses to particular sounds, these sounds are good candidates for use in the program. Use of broad band sounds, as discussed in Section II, is also recommended. Finally, consideration should be given to use of several broad spectrum sound stimuli (e.g., several different words, different noise makers, etc.) to discourage habituation to a particular sound cue.

Selection of Reinforcement: A first consideration is whether gazing at a blinking or flickering light functions as reinforcement for the student, i.e., if he orients to a light source, will he continue to gaze at it while the light is flashed on and off? Light sources have been reported to be particularly effective reinforcers with deaf/blind students, although they may also increase stereotypic behaviors in these students (cf. Tait, 1977). In addition to the light source used in training, use of other powerful reinforcers, such as edibles or tangibles, is also recommended in both programs to maintain high motivation.

In the OMR program, selection of materials which have intrinsic reinforcement value for the child is suggested. Examples might be reaching for a bottle of bubbles or a favorite toy or noisemaking object, or performing a discrete motor task such as pulling a favorite object out of a can or box. The opportunity to manipulate the object can then be used as part of the reinforcement procedures. Use of the flicking light, as designated in the programs, in conjunction with edible or tangible consequences described here, and social reinforcement, will thus result in multiple sources of reinforcement for each response. The importance of establishing clear, consistent responses in order to accomplish audiometric testing, rather than primary concerns with functional programs and generalization, is the primary reason that use of multiple, powerful tangible reinforcers is emphasized.

VRL Program

Behavioral Objective:

Given a combined auditory and light stimulus presented at a designated angle to the right or left of midline (no less than 45 degrees), the student will localize to the stimulus by turning his head to the appropriate side within 5 seconds to a criterion of at least 90% correct on 2 out of 3 days.

Materials:

1. **Lights.** Two high intensity (75w) bare bulb lights with silent switches cut into the cords and marked R or L. The light can be a clamp on variety as illustrated below.

For ease of operation, the cords from the lamps are plugged into a single extension cord.

The intensity of the light is initially faded by reducing the wattage of the bulb from a 75w bulb to a 60w bulb, to a 40w bulb, to a 25w bulb. The intensity of the 25w bulb can then be further faded by placing layers of tissue paper across the front of the light fixture. As an alternative, you may also use two bare bulb lamp sockets

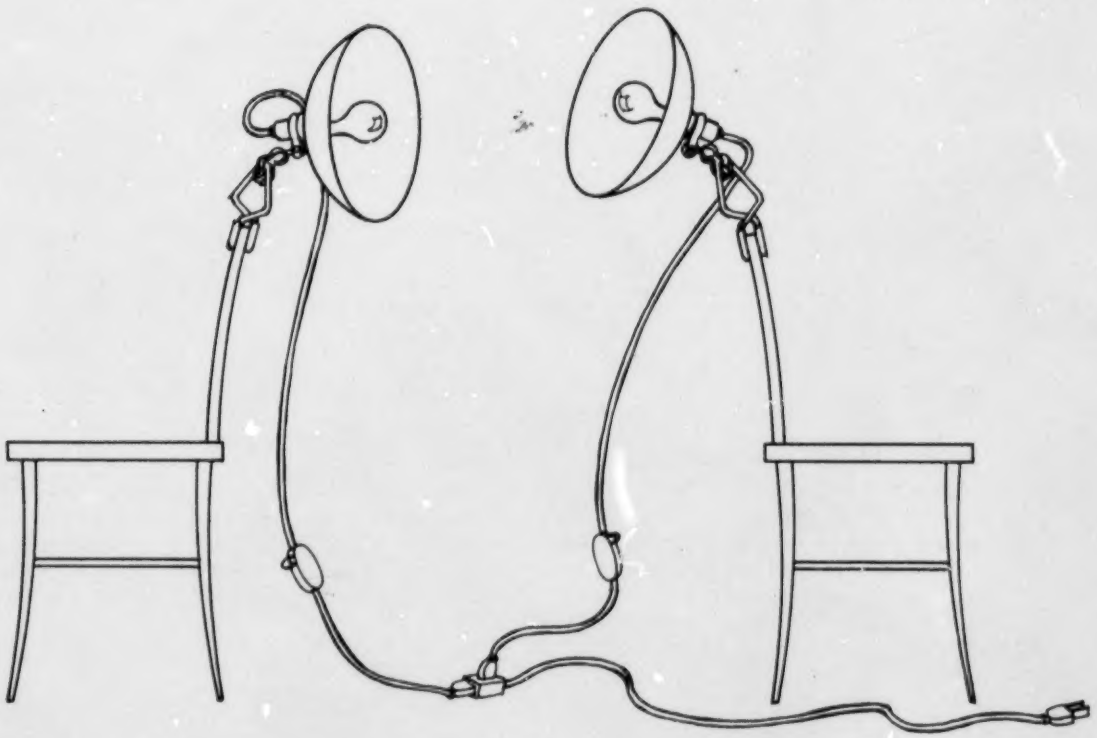


Figure 5

and two large, opaque plastic toy piggy banks or lamp shades. These may be yellow, green, or red, but both banks should be the same color. The banks are slit open at the back to allow insertion of the socket inside the bank, as illustrated in Figure 6.

The intensity is again faded by using lower watt bulbs, and silent switches are used as described above.

Decision as to which type of light to use will depend upon the individual student. For some students, the bare light bulbs may be too bright, as indicated by cringing, squinting, turning away from the light source, or ceasing to turn to the light after 1-2 initial trails. For these students, use of the pigs may be more appropriate. For other students, particularly those with suspected or documented low vision, the light inside the pigs may not be intense enough, and the bare bulb may be necessary. Unless you know the student has extremely poor vision, begin with the pigs. If you fail to obtain reliable responses during initial baseline phases (see below) begin again using a bare bulb.

2) **Noisemakers:** If you have identified sounds that the student responds to through the informal assessment, try to use them in the program. Ideally, the noisemakers should be easy to activate and small enough to be hidden from the student's view. Maracas are a good example.

If the sound stimulus is going to be speech, two tapes of speech cues and two small casette recorders are required, one for each side. The project did not obtain validation data using speech as sound cue in this program, so further details are not provided.

3) **Table and Set Up.** A narrow table and two chairs, positioned as shown in Figure 7:

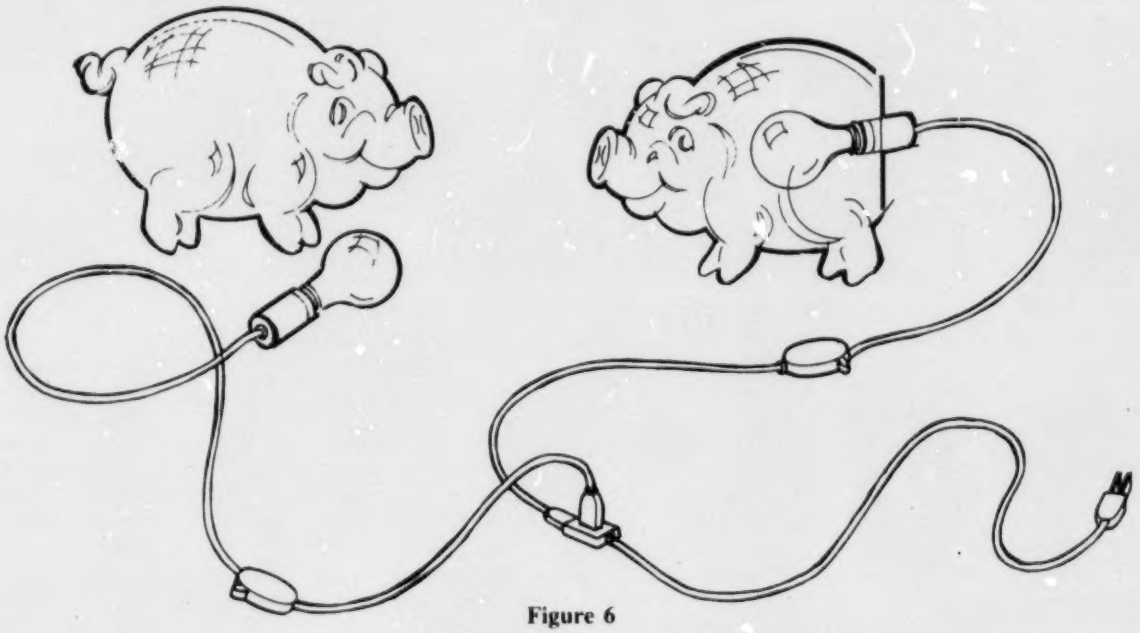


Figure 6

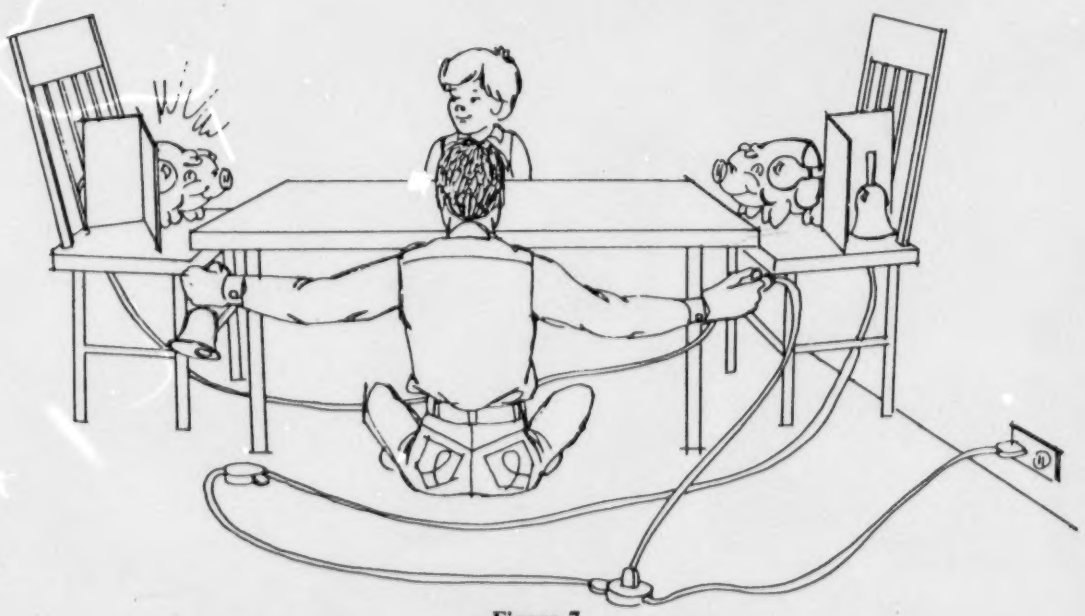


Figure 7

The noisemakers are placed on the seat of the chair and hidden from view by a small, flat screen. (In the above illustration the screen is folded only so that the reader can see where the pigs are placed. The flat screen should completely hide the teacher's hand from the student's view.) The teacher is seated on the floor across from the student, with his arms and shoulders hidden from the student's view by the table. The teacher can thus extend one arm to activate the noisemaker, and simultaneously activate the light switch with the other hand, without providing a visual cue to the student. The student should be seated in a comfortable position that makes a head turn clearly visible.

Setting:

Sessions are run in the classroom with average noise levels.

General Procedures:

This program uses a stimulus shift paradigm. A head turn is first established to a light stimulus. Light and sound stimuli are then paired as the discriminative stimulus for the head turn. The light is then systematically faded until the responses has shifted to the auditory stimulus alone. This shift *may* or *may not* occur. In either case, results should be shared with an audiologist. The major program parts are described below and the task analysis follows.

Auditory Baseline: During this phase, a sound stimulus is activated randomly to the right or left, but correct responses are not reinforced. The baseline continues for a minimum of 3 days or until a stable response pattern is observed. It is extremely important to obtain baseline data. If the student already shows a consistent localizaion response to sound during this baseline, he may already be ready for formal assessment. For these students, participation in the program may be unnecessary.

Light Baseline: During this phase, the lights alone are activated randomly to the right or left. Correct responses are not reinforced. As detailed in the task analysis, the goal of this phase is to determine the optimal position of the lights. Optimal positioning is particularly important for students with visual disabilities such as visual field losses, extreme low vision, etc.

However, if a student remains in baseline for too long, his responses to the light may undergo extinction. Therefore, as soon as an optimal location is identified according to the criteria in the task analysis, training should begin.

This baseline phase may also be used to determine if the pigs or the bare bulbs are most appropriate. Begin baseline using the pigs. If you are unable to obtain consistent responses after following the task analysis, repeat the baseline using a bare bulb, but watch for indications such as squinting or grimacing which suggest the light is too bright.

Training Light Alone. During this phase, consistent responding to the light is established by reinforcing correct localization responses.

Training Light and Auditory Stimulus. During this phase, the light and auditory cue are activated simultaneously and the intensity of the light is systematically faded. Throughout this phase, probe trials to the auditory cue alone are randomly interspersed with the training trials.

Training Auditory Stimulus Alone. In the last phase of the program, the auditory cue alone is presented to determine if the student has transferred control of the response from a light cue to a sound cue.

Probe Trials

Throughout all phases of this program, probe trials are trials in which an auditory stimulus is presented alone as the cue for a head turn. On all probe trials, present only the sound stimulus to the R or L side as designated on the data sheet. Wait 5 seconds for a response. The response must be a clear head turn. *Reinforce* correct responses by immediately flashing on and off the light on the side to which the student's head is turned. In addition, deliver the other reinforcement being used in training.

ALL head turns on probe trials should be reinforced, regardless of whether they are to correct side or not. Differential hearing in each ear, brain damage or other factors may cause the student to perceive all sounds on one side, regardless of the side to which the sound is actually delivered. For this reason, monitor the side to which the student consistently turns during probe trials and share this data with the student's audiologist.

Data and Graphing:

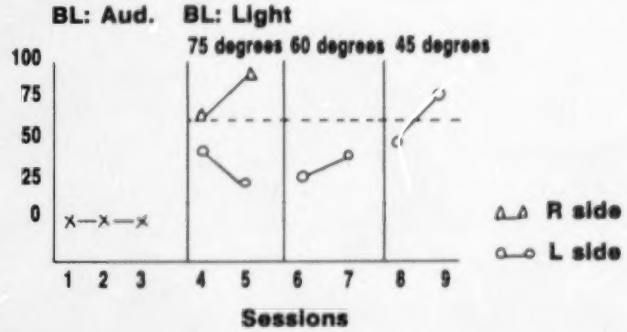
A sample data sheet and graph from a project student follow the task analysis.

Adaptations:

The fading procedures used here may also be adapted for use with students who do not show clear head turn responses, but who do show other consistent responses to a light stimulus. Examples might be a shift of the eyes toward the light or cessation of activity in response to a centrally positioned light. If such alternative responses are selected for training, reliability of measurement is crucial for a smooth fading procedure. Adaptations have not been validated with project students.

Part I: Auditory and Light Baselines

Teacher Does	Student Does
1. Position the student as described above. Wait until the student's head is in midline and then activate only the sound stimulus randomly to the right or left as indicated on the data sheet. Score a plus (+) for a head turn response; a minus (–) for any other response (the purpose of this program is to establish a *clear, reliable* response for audiological assessment). Do not reinforce responses. Reinforce intermittently for appropriate sitting, etc. Repeat a minimum of 3 days or until a stable response pattern is observed.	1. Turns head in direction of sound stimulus.
2. Position student as described above. Wait until the student's head is in midline and then activate only the high intensity 75 watt light stimulus. Follow the random order to R or L on the data sheet. Score a plus (+) for a head turn; a minus (–) for any other response. Do not reinforce responses. Reinforce intermittently for appropriate sitting, etc. Take two days of baseline. The criteria for a consistent response is 60% correct head turns for at least 1 of the 2 days on *each* side. Using this criteria, follow these steps: a. Begin with both lights at 75 degrees. If criterion is met for each side, go to Part II. If criterion is not met for one or both sides, go to b for the side(s) that did not meet criterion. Stop baseline for the side that has met criterion. b. Take baseline with one/both lights at 60 degrees. If criterion is met, go to Part II. If criterion is not met, go to c. c. Take baseline with one/both lights at 45 degrees. If criterion is met, go to Part II. If criterion is not met, train a head turn using a prompt procedure and then go to Part II. The sample graph below reflects this procedure.	2. Turns head toward light in each direction at a minimum of 45 degree angle.



Since the right side met criterion at 75 degrees (1 out of 2 days at 60% or better), baseline stopped. The left side did not meet criterion until the light was moved to 45 degrees. Light training should now begin with the R light at 75 degrees and the L light at 45 degrees.

Part II: Training Response to Light Stimulus Alone

CRITERION: 90% correct trials (R and L sides combined) on 2 out of 3 days.

Teacher Does	Student Does
1. Position student and follow data sheet as described in Part I. Using 75 watt bulb, turn on light on designated side. Wait up to 5 seconds for a response. Reinforce a head turn that occurs within 5 seconds and score (+). If the student does not make a head turn, prompt the student through a response, do not reinforce, and go on to the next trial. (Some students may require more extensive prompting and fading and/or a more gradual thinning of the reinforcement schedule.)	1. Turns toward light.

Part III: Training a Response to Light Plus Auditory Stimulus

CRITERION: 90% or more correct on 2 out of 3 days for each step.

Teacher Does	Student Does
1. Use the same procedure as in Section II — except add the auditory stimulus. Turn on the 75 watt light and the sound stimulus at the exact same time.	1. Turns head toward light and sound.
2. Follow number one above except use a 60 watt bulb. FOR STEPS 2-6, RUN 5 AUDITORY PROBE TRIALS RANDOMLY INTERSPERSED AMONG THE 20 TRAINING TRIALS. IF PROBE TRIALS REACH 90% FOR 2 CONSECUTIVE DAYS, GO TO PART IV.	2. Same.
3. Same procedure as in step 2, except use a 40 watt bulb.	3. Same.
4. Same, except use a 25 watt bulb.	4. Same.
5. Same, except use a 25 watt bulb with a 1 tissue paper layer.	5. Same.
6. Same, except use a 25 watt bulb with 2 tissue paper layers.	6. Same.

If the teacher feels it is necessary, he may make the fading of the light stimulus even more gradual by improvising with this same technique.

Part IV: Training a Response to Auditory Stimulus Alone

CRITERION: 100% correct on 2 out of 3 consecutive days.

Teacher Does	Student Does
1. Run these training trials exactly as the probes in Part III. Run a few trials with light and sound combined, then run 10-15 trials using the auditory stimulus alone.	**1. Turns head toward sound.**
Reinforce correct responses by flashing the uncovered bulb and using the established reinforcer. When the student responds incorrectly put him through the correct response and go on to the next trial.	
If the student scores 0%-20% for 5 consecutive days, cease training, evaluate the data and determine whether to go back through the procedure a second time. Failure to respond to the auditory stimulus does not mean the student has failed the program. She is still conditioned to the light which gives the audiologist a response to work with during formal assessment.	
If transfer to the auditory stimulus is achieved, the audiologist can use this response in formal testing. However, the student may fail to generalize the skill to a new person or setting, and you may need to work with the audiologist to establish the response in the test room.	

A sample data sheet for the VRL program is found on the next page. Each wide column contains data for one day, or a total of 20 training trials and 5 probe trials. The first narrow column indicated the trial number and the second indicates which side to activate the stimulus on, left or right. The student's score, (+) for a correct response, (−) for an incorrect response, is recorded in the third column. Probe trials are indicated by a (*). Probe trials and training trials are calculated separately and plotted as separate lines on the graph.

During auditory and light baseline phases, it is recommended that only 10 trials of baseline be given each day. The data sheet can be modified accordingly.

Sample performance data from one of the project students who completed the VRL program are found in Figure 8. Figure 8 shows that M.F.'s responses during the initial auditory baseline were inconsistent. However, she reached criterion on the light baseline in two days. Once training with the paired light/auditory cue began, as indicated by the •——•, her performance during all of the fading steps remained high. Her acquisition of the response to sound alone on the probe trials, indicated by x——x, was more gradual. When the fading steps had been completed, her performance to the auditory cue alone did not meet criterion. Retraining began at the last fading step (25 w. + auditory) and the probes quickly reached 100%. Responses to the auditory probes were then maintained by mixing 15 training trials (combined auditory and light cue) with 10 auditory probes in each session.

M.F. was a severely retarded three year old girl whose hearing status was undetermined. Bilateral cataracts had been surgically removed. Subsequent to completion of the program, formal audiological evaluation indicated hearing within normal limits.

STUDENT'S NAME: _____

AUDITORY TRAINING: Visually Reinforced Localization

See attached program for description of steps.

DATE:	STEP:		DATE:	STEP:		DATE:	STEP:	
TRIAL	L/R	SCORE	TRIAL	L/R	SCORE	TRIAL	L/R	SCORE
1	L		1	L		1	R	
2	R		2	R		2	L	
3	L		3	R		3	L	
P	R	•	4	L		P	R	•
4	R		P	R	•	4	R	
5	L		5	R		5	L	
6	R		6	L		6	R	
7	L		P	L	•	7	L	
P	L	•	7	R		8	R	
8	R		8	L		P	L	•
P	L	•	9	R		9	L	
9	L		10	R		P	R	•
10	R		P	R	•	10	R	
11	R		11	L		11	L	
12	R		12	L		12	L	
P	L	•	13	R		13	R	
13	L		14	L		L	•	
14	R		15	L		14	R	
15	L		P	R	•	15	R	
16	R		16	R		R		
17	L		17	L		17	L	
P	R	•	18	R		P	R	•
18	L		P	L	•	18	L	
19	L		19	R		19	L	
20	R		20	L		20	R	
Total #C_____%C_____			Total #C_____%C_____			Total #C_____%C_____		
Left #C_____%C_____			Left #C_____%C_____			Left #C_____%C_____		
Right #C_____%C_____			Right #C_____%C_____			Right #C_____%C_____		
Probes #C_____%C_____			Probes #C_____%C_____			Probes #C_____%C_____		

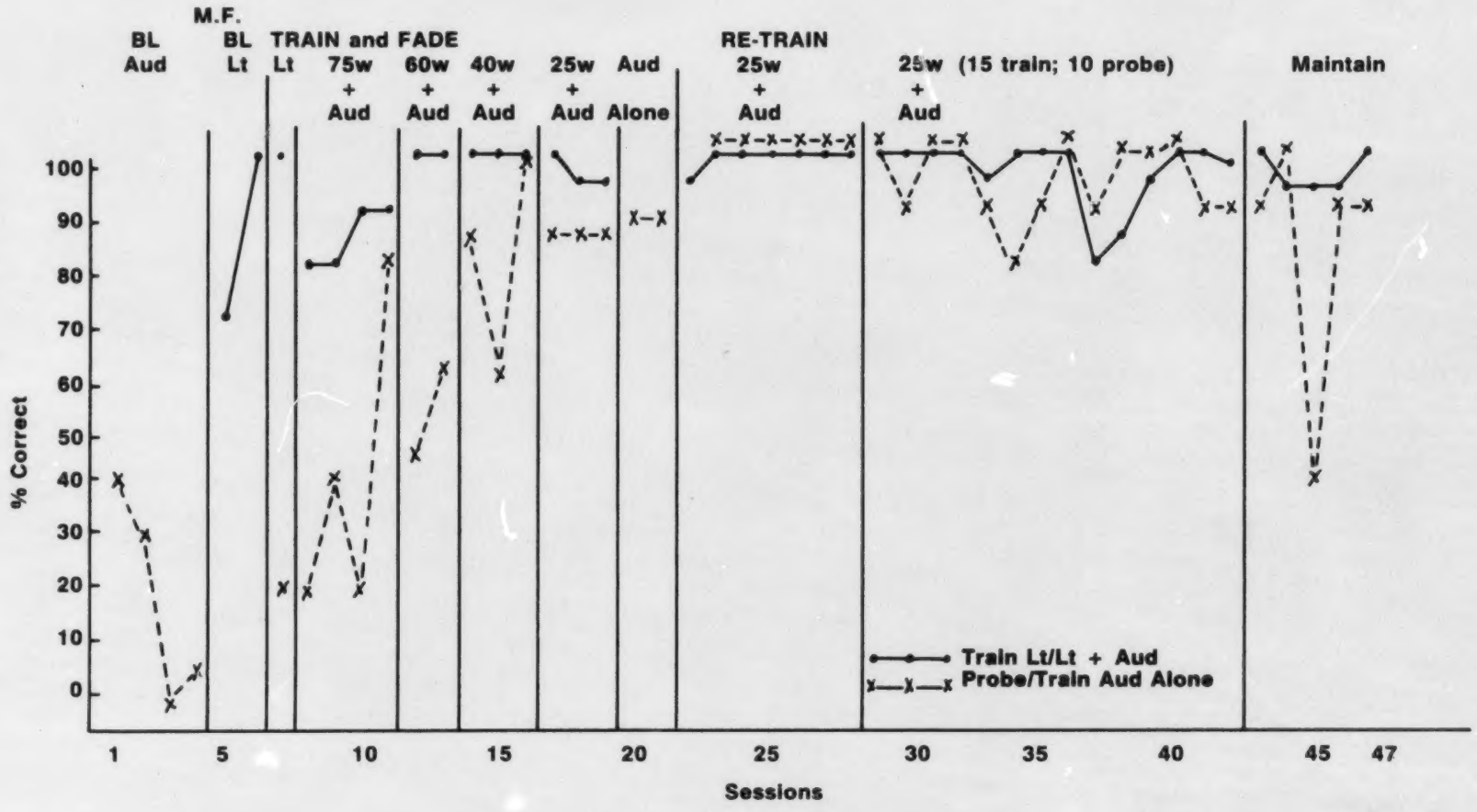


Figure 8: VRL PROGRAM

OMR Program

Behavioral Objective:

When presented with appropriate training object(s) (e.g., reinforcing toy to reach for, fine motor task, etc.) and a light and/or auditory stimulus presented on a variable interval schedule of 1-10 seconds, the student will reach for the object within 3 seconds of the auditory cue, but not before, to a criterion of 80% correct out of 20 trials per day for two days or 100% correct for one day.

Materials:

1) **Objects:** Reinforcing or motivating object(s): something the student will reach for such as a ball, bubbles, noisemaking toy or instruments, or other toy he or she particularly likes; a fine motor response such as taking a block and putting it in a can or through a hole, or putting a stacking ring on a stick; pieces of food the student will reach for.

2) **Light Stimulus:** The light fixture must be one which can hang or protrude over the desk or table in order to shine directly on the object without getting in the way of the student's response. A desk lamp such as the one in the diagram below works well. The light should have a silent switch built in to the cord which allows the teacher to turn the light on and off without being seen or heard.

3) **Auditory Stimulus:** Selection of an auditory stimulus should be made in light of considerations discussed in the introduction to this section. If speech is used (e.g., "get the toy" or "put it in"), a card or clipboard is needed to cover your mouth to avoid visual cues. If noisemaking objects are used, it is desirable to have a pair of identical objects for use in training. This enables the teacher to place one object of the pair on the table for the student to reach for another object under the table hidden from view to activate the sound cue.

4) **stopwatch, data sheet.**

5) **narrow table or desk, chairs.**

Setting:

Work sessions are run in the classroom with average noise levels. Teaching is done on a discrete trial basis. Sit across from the student in a position which allows you to hide the light and auditory cueing devices from the student's view.

General Procedures:

A stimulus shift procedure is used to establish a motor response to an auditory cue. A systematic error correction procedure is used to establish the response to a light cue. Light and sound cues are then paired and stimulus control of the response is transferred to the sound cue through fading the intensity of the light cue.

For each part of the program, follow these general procedures: Set up a light as designated above. At the beginnig of each trial, present the object on the table. Give a cue to keep hands down if needed and wait until student's hands are at rest. From that point wait a variable number of seconds (from 1-10) as designated on the data sheet. Then activate the light and/or sound stimulus out of the view of the student. Follow the designated steps in each task analysis for assistance and fading procedures.

For all parts of the program, correct and incorrect responses are defined as follows: For a correct response to be recorded, the student *must wait* for the light and or auditory stimulus before reaching for the object. He must then reach for the object within 3 seconds of the presentation of the light and/or sound stimulus. The amount of assistance to be provided in teaching the reach response is designated in the task analysis. Immediately deliver reinforce-

Figure 9

ment (access to the object or edible that was reached for, social praise, etc.), after a correct response.

Error Correction Procedure. If the student begins to reach for the object or perform the task *before* the light and/or auditory stimulus, a specific correction procedure is used. The student is told "no" and hands are returned to the waiting position. A (−) is recorded on the data sheet. The entire trial is then repeated, including waiting the same number of seconds for the interval before activating the cue.

If the student again responds incorrectly (e.g., he fails to wait for the cue), his hands are again placed in the starting position and the trial is again re-presented. The trial is repeated *as many times as needed* until the student makes a correct reponse. When s/he does respond correctly, social reinforcement and access to the object or task are used, but no tangible reinforcement is delivered. This correction procedure is used throughout the program. It should be noted that during the initial stages of training, use of this procedure may increase the overall length of a session, as numerous repetitions of a trial will require additional time.[1]

Auditory Baseline. During this phase, the auditory stimulus by itself is used as a cue for the response. If speech is used, cover your mouth with a clipboard, wait a random number of seconds and give the cue. If a noisemaker is used, hide it from view, wait a random number of seconds, and activate the noisemaker. Do not reinforce responses, but intermittently reinforce for appropriate sitting and attending. Baseline continues for three days or until a stable response pattern is observed. It is extremely important that baseline data be obtained. If the student shows a consistent response to an auditory cue, he may already be ready for audiological assessment and the training program may not be necessary.

Training Light Alone. During this phase, consistent responding to the light is established through reinforcement and the correction procedure. For some students, it may be necessary to begin light training in a dark room if the response is not learned in the classroom.

Training light and Auditory Stimulus. The light and auditory cue are activated simultaneously and the intensity of the light is systematically faded. Throughout this phase, probe trials to the auditory cue alone are randomly interspersed with training trials.

Training Auditory Stimulus Alone. The auditory cue is presented alone to determine if the student has transferred control of the response from a light cue to a sound cue.

Probe Trials

Beginning with Part III of the program, 5 probe trials are randomly inserted into each group of 20 training trials. On these probe trials, the auditory stimulus is presented alone, without the paired light stimulus. Reinforce correct probe trials with whatever reinforcement is being used. In addition, rapidly flick the light on and off several times.

Data and Graphing:

A sample data sheet and graphs from selected project students follow the task analysis.

[1] This correction procedure operates on the principle of negative reinforcement (however, it is *not* a punishment procedure). If you are concerned about use of negative reinforcement procedures, you may adapt a different correction procedure; however, this is the procedure that was used during validation of the program.

Part I: Auditory Baseline

Present the object(s) to the student and make sure she becomes interested. Place it on the table within the student's reach. If necessary, say and sign, "hands down" and wait until the student's hands are independently at rest. Begin the interval. After the appropriate interval of seconds has elapsed, as designated on the data sheet, activate the sound stimulus. If speech is the cue, be certain to shield the lower half of your face with a card at the start of the interval. If a sound maker is the auditory stimulus, present one object on the table and hold an identical object out of sight below the table. Activate the one that is out of sight in order to avoid giving a visual cue.

Teacher Does	Student Does
1. Position the student and materials as described above. Wait the appropriate interval and activate the auditory cue. Do not reinforce responses. Reinforce intermittently for appropriate sitting, etc. Repeat a minimum of 3 days or until a stable response pattern is observed.	1. Student takes object and/or makes motor response after the cue is activated.

Part II: Operant Response to Light Only

Present the object(s) to the student and make sure she becomes interested. Place it on the table within the student's reach. If necessary, say and sign, "hands down" and wait until the student's hands are independently at rest. Begin the interval. *After* the appropriate interval of seconds has elapsed, as designated on the data sheet, activate the light with one hand held out of the student's sight. The light bulb used in initial training is 75 watts.

After the light has been turned on, give as much assistance as designated in the task analysis and wait five seconds for a response. If the student responds prior to the presentation of the light stimulus, or responds incorrectly, return his/her hands to the starting position and begin again, using the correction procedure described earlier.

Teacher Does	Student Does
1. Position the student and materials as designated above. Wait the correct interval and activate the light stimulus. Wait up to 3 seconds for a response. If the student waits for the light, put him through the response and score (+). If the student does not wait, use the correction procedure described earlier and score (–).	1. Student waits for the light and takes object/makes motor response when fully put through the response.
2. Same as step 1, but after student waits for the light, prompt the response by touching his hand.	2. Student waits for the light and takes object/makes motor response when prompted at hand.
3. Same, but no assistance given to perform response.	3. Student waits for the light and takes object/makes motor response independently.

If the student is unable to learn the response or does not learn to *wait* for the cue in a normally lit room, training can be done first in a dark room with a penlight inside a yellow or green plastic object or with the same set up as above. After the student learns the response the classroom light can be gradually faded in.

Part III: Operant Response to Paired Light and Auditory Stimuli

Continue to use the instructional procedures and error correction procedures described in Part I, but pair the light with an auditory cue. If speech is the auditory stimulus, be certain to shield the lower half of your face with a card, clipboard, etc. To prevent the shield from becoming an additional visual cue, shield your face at the start of the interval and then begin waiting the designated number of seconds before delivering the paired light/auditory stimuli. If a sound maker is the auditory stimulus, present one object on the table and hold an identical object out of sight below the table. Activate the one that is out of sight. During training, intersperse five probe trials in which the auditory cue alone is presented.

Teacher Does	Student Does
1. Use a 75 watt bulb in classroom light. Activate the light and sound cues simultaneously. For steps 2-5, run 5 probe trials randomly interspersed among the 20 training trials. If probe trials reach 90% for 2 consecutive days, go to part IV.	1. Student waits for stimulus and performs response without assistance.
2. 60 watt bulb.	2. Same as above.
3. 40 watt bulb.	3. Same as above.
4. 25 watt bulb.	4. Same as above.
5. 25 watt bulb with white tissue covering light.	5. Same as above.

Part IV: Training a Response to Auditory Stimulus Alone

Teacher Does	Student Does
1. Run these trials exactly as the probes in Part II. Run a few trials with light and sound, combined, then run 10-15 trials using the auditory stimulus alone.	**1. Performs motor response.**
Reinforce correct responses by flicking the light and using the established reinforcer. When the student responds incorrectly put him through the correct response and go on to the next trial.	
If the student scores 0-20% for 5 consecutive days, cease training, evaluate the data and determine whether to go back through the procedure a second time. Failure to respond to the auditory stimulus does not mean the student has failed the program. She is still conditioned to the light which gives the audiologist a response to work with during formal assessment.	
If transfer to the auditory stimulus is achieved, the audiologist can use this response in formal testing. However, the student may fail to generalize the skill to a new person or setting, and you may need to work with the audiologist to establish the response in the test room.	

A sample data sheet for the OMR program is found on the following page. Each column contains data for one day, or a total of 20 training trials and 5 probe trials. The first narrow column indicates the trial number. The second column indicates the number of seconds to wait before activating the stimulus. The student's score, (+) for a correct response and (−) for an incorrect response, is recorded in the third column. Probe trials are indicated by a (*). Probe trials and training trials are calculated separately and plotted as separate lines on the graph.

During the auditory baseline phase, it is recommended that 10 trials of baseline be given each day. The data sheet can be modified accordingly.

Performance data from two project students for the OMR program are shown in Figure 10. Responding to the light or combined light and auditory stimulus is indicated by •———•. Responses to auditory probes are indicated by x———x. The top graph for J.E. indicates no responses to the light or auditory cues during baseline (a light baseline was obtained for validation purposes). J.E. did not learn to wait for the light and make an independent reach response (Step 3) until training was moved to a dark room. After a summer recess, training resumed with a paired 75 w bulb and auditory stimulus. J.E. was accidentally faded from a 75 w to a 25 w bulb, but his auditory probes remained at 80% and he required only two fading steps. His performance to an auditory cue alone remained above 80% throughout the last phase of the program. J. E. participated in a formal audiological assessment and was found to have a mild to moderate hearing loss.

In contrast, M.S.'s data, shown on the bottom graph, also show no responding to auditory cues during baseline, but he learned rapidly to wait for the light before making a response. After a summer break, he progressed rapidly through five fading steps of combined light and auditory cues. However, he failed to ever respond to an auditory probe, and his performance remained at 0% during the final program step. Formal audiological evaluation indicated a profound bilateral sensorineural hearing loss.

STUDENT'S NAME: _____

AUDITORY TRAINING: _____ **Training An Operant Motor Response** _____

See attached program for details of each step.

DATE:			**DATE:**			**DATE**		
STEP:			**STEP:**			**STEP:**		
T	**I**	**S**	**T**	**I**	**S**	**T**	**I**	**S**
1	5		1	4		1	6	
2	3		2	8		2	7	
3	8		3	9		*P	8	*
4	7		*P	5	*	3	3	
5	2		4	2		4	9	
*P	9	*	5	8		5	5	
6	1		6	1		6	7	
7	6		*P	7	*	7	2	
*P	8	*	7	6		8	9	
8	4		8	9		*P	1	*
9	9		9	4		9	10	
10	3		*P	8	*	10	7	
*P	7	*	10	3		11	4	
11	10		11	10		12	8	
12	6		12	7		*P	3	*
*P	8	*	13	2		13	9	
13	9		14	8		14	5	
14	3		15	4		15	2	
15	5		*P	9	*	16	7	
16	7		16	6		*P	5	*
17	6		17	5		17	9	
18	9		18	2		18	2	
*P	3	*	19	8		*P	5	*
19	6		*P	10	*	19	4	
20	2		20	4		20	8	
#C = _____			#C = _____			#C = _____		
%C = _____			%C = _____			%C = _____		
# P-C = _____			# P-C = _____			# P-C = _____		
% P-C = _____			% P-C = _____			% P-C = _____		

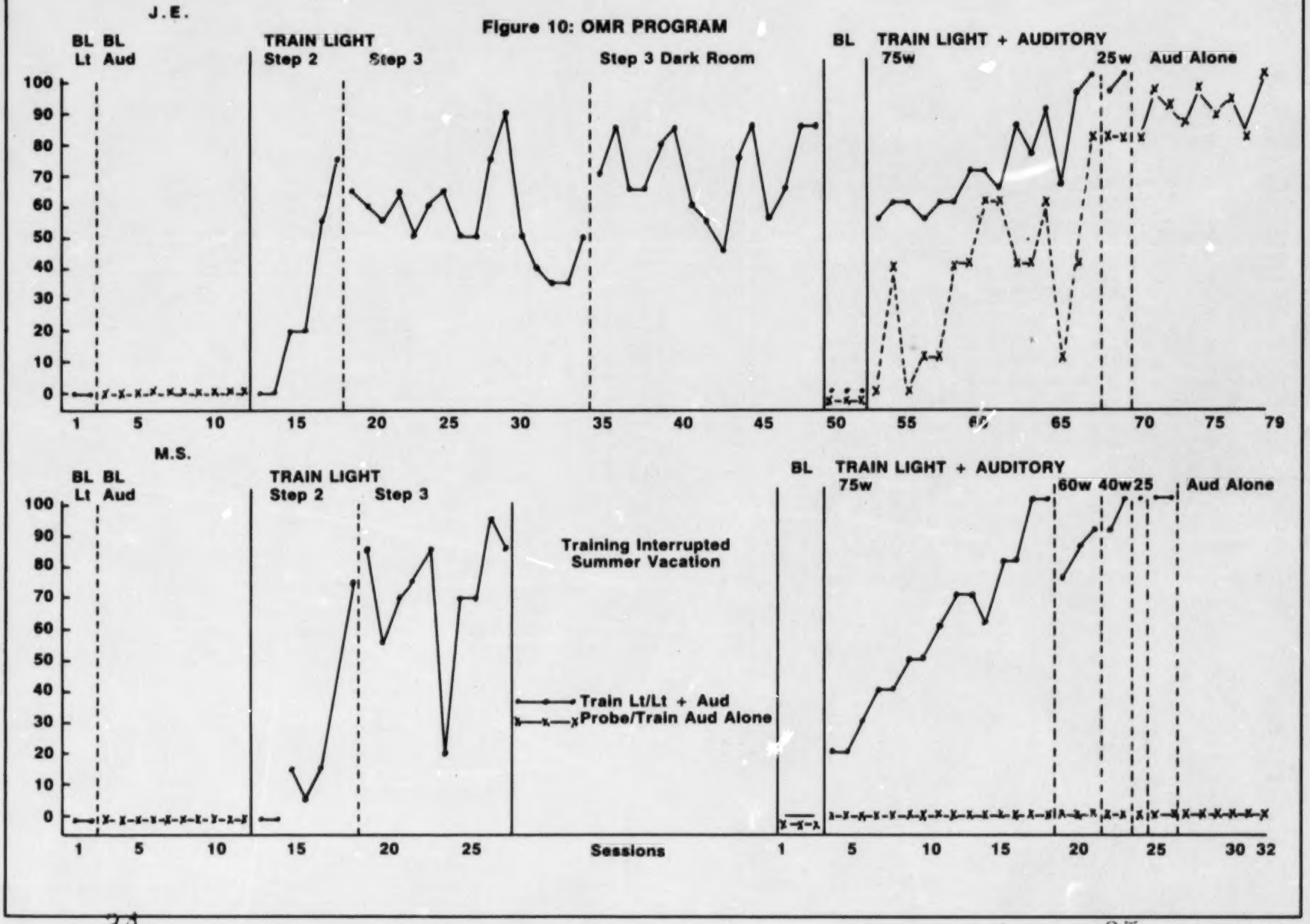


Figure 10: OMR PROGRAM

IV. Teacher Follow Up To Formal Assessment

Once an audiologist has successfully evaluated the hearing of a severely handicapped student, the next major task is to provide the child with a system of amplification (i.e., hearing aids) best suited to his needs. Whether to provide aids for one or both ears, the amount of amplification provided by the aids, the type of aid, etc., are all questions considered by the audiologist in recommending an aid for a student. The following sections address 1) understanding an audiogram; and 2) basic information about hearing aids and amplification.

Understanding an Audiogram

An audiogram is a graphic representation of responses to auditory stimuli during audiometric assessment. The numbers across the top of the horizontal axis are designated in Hertz (H_z) and indicate the frequency of the auditory stimuli. Low frequency sounds (i.e., 250 H_z) are shown on the left and high frequency sounds (i.e., 8000 H_z) are shown on the right. The numbers on the vertical axis represent intensity of the sound measured in decibels (dB HL). The 0 dB level does not mean *no* sound; rather it denotes the faintest level at which normal hearing persons can hear the different frequencies. The increasing number above 0 dB (below on the audiogram) indicate increasing intensity of the sound. Thus, an individual with a hearing loss may not hear a sound at 0 dB (normal hearing level). However, when the sound is presented at 30 dB, a more intense level, he is able to hear it. An audiogram therefore reflects an individual's hearing level (the intensity at which a sound must occur in order for the individual to hear it) as a function of frequency.

Typically, pure tones are the auditory stimuli used in testing, because their frequency characteristics can be carefully controlled and determined. When the tones are delivered through ear phones or into the tests room through a speaker, the measurement is called *air conduction* testing. When the tones are delivered via vibration through the skull bones, the procedure is called *bone conduction* testing (see Chapter 3).

Figure 11 represents an audiogram of a normal hearing person. The audiogram is a graphic illustration of a person's auditory sensitivity as a function of frequency. The symbols (O,X,[,]) shown on the audiogram represnt the faintest intensity level at which the individual responds to the various tones 50% of the time. This level is called the threshold.

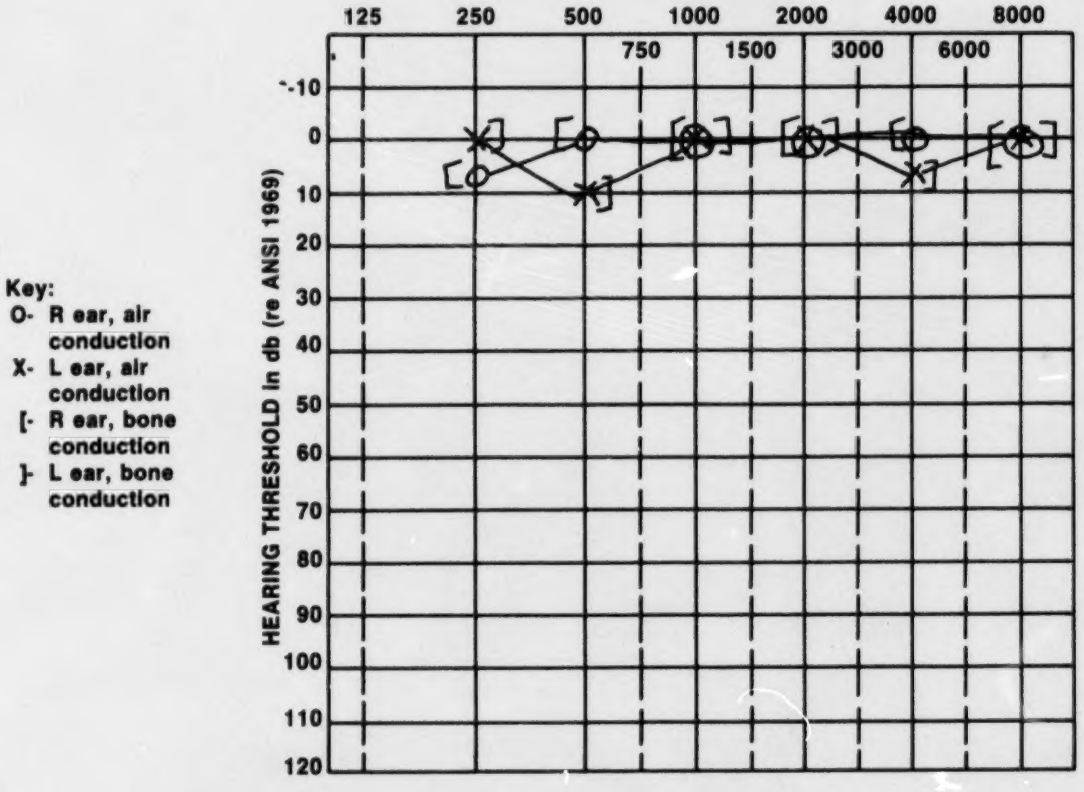


Figure 11

In contrast, Figure 12 indicates a mild low frequency hearing loss. Air conduction thresholds indicate that for the right ear, low frequency sounds (250 and 500 H_Z) must be presented at 40 dB to be heard, while a 1000 H_Z tone must be presented at 30 dB to be hard. Higher frequency sounds, however, are heard within normal limits. Air conduction measurements for the left ear indicate normal hearing across all frequencies. Bone conduction measurements for both ears also fall within the normal range. In the right ear, then, the hearing level is good when sound bypasses the outer and middle ear and is delivered directly to the inner ear through bone conduction. However, when low frequencies must pass through the outer and middle ear, they must be considerably more intense (30-40 dB) to be heard. To the audiologist, such a result would suggest a conductive loss (see Chapter 1) in the right ear, and she may refer the student to an otologist to determine the cause of the conductive loss.

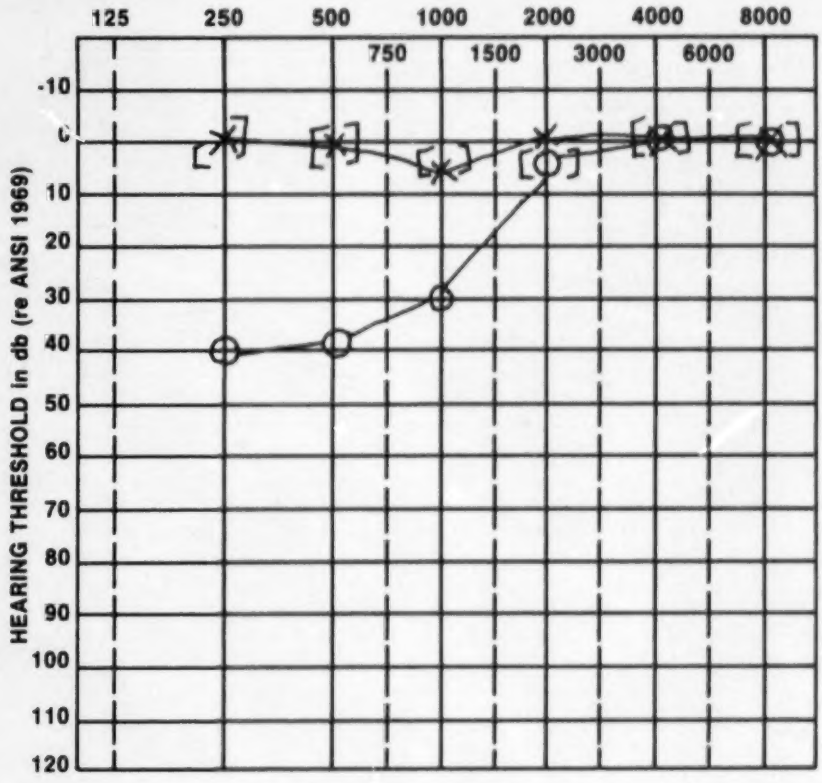


Figure 12

Figure 13 presents an audiogram representative of a sensorineural loss, with poorer hearing in the high frequencies. Note that higher frequency stimuli must be presented at 70-80 dB to be heard in either ear. The loss is considered to be sensorineural because thresholds are approximately the same for air conduction and bone conduction.

While typical audiograms are plotted in terms of air and bone conduction responses to pure tone stimuli, as in Figures 11-13, audiograms for severely multiply handicapped students may appear somewhat different. If, for example, the audiologist does not obtain consistent responses to pure tones using some form of behavioral test procedures such as BOA, VRA or TROCA (see Section 3), he may instead use filtered speech or warbled pure tones as the auditory stimulus. Similarly, if a student is particularly difficult to test, the audiologist may plot only those responses considered to be reliable and valid on the audiogram. A further issue concerns wearing earphones. If the student will not tolerate wearing earphones, testing must be done in the sound field, making differential hearing in each ear impossible to assess. The response to auditory stimuli in the sound field may only reflect the acuity (sensitivity) of the better ear.

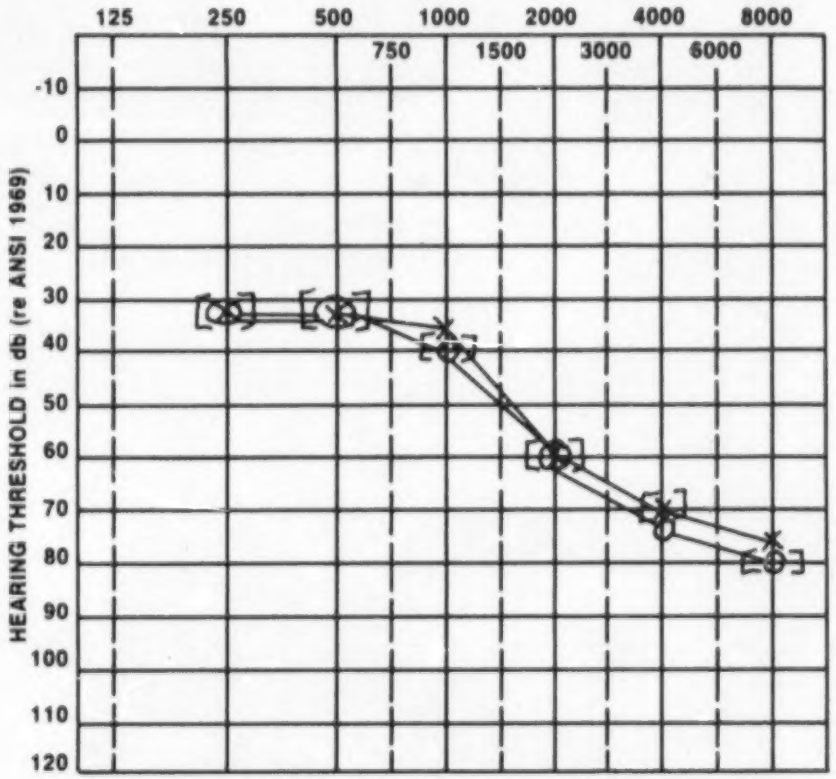


Figure 13

Figure 14, for example, presents the audiogram of a project student. After an initial evaluation suggesting a moderate loss on the basis of BOA, this student had completed the OMR program in Section 3 using speech as the sound stimulus. To facilitate generalization of the conditioned response, speech (filtered speech rather than pure tones) was used as the auditory stimulus during testing.

Figure 14 indicates that during this evaluation a filtered speech band of 1200-2400 H_z was heard at 40 dB and a 2400-4800 H_z filtered speech band was heard at 60 dB, suggesting a mild to moderate loss with better hearing in the lower frequency range.

As a further example, Figure 15 presents another audiogram from a project student. This figure shows that reliable responses were observed only to warbled tones at 250 H_z delivered at 85 dB intensity. This student had a profound bilateral hearing loss.

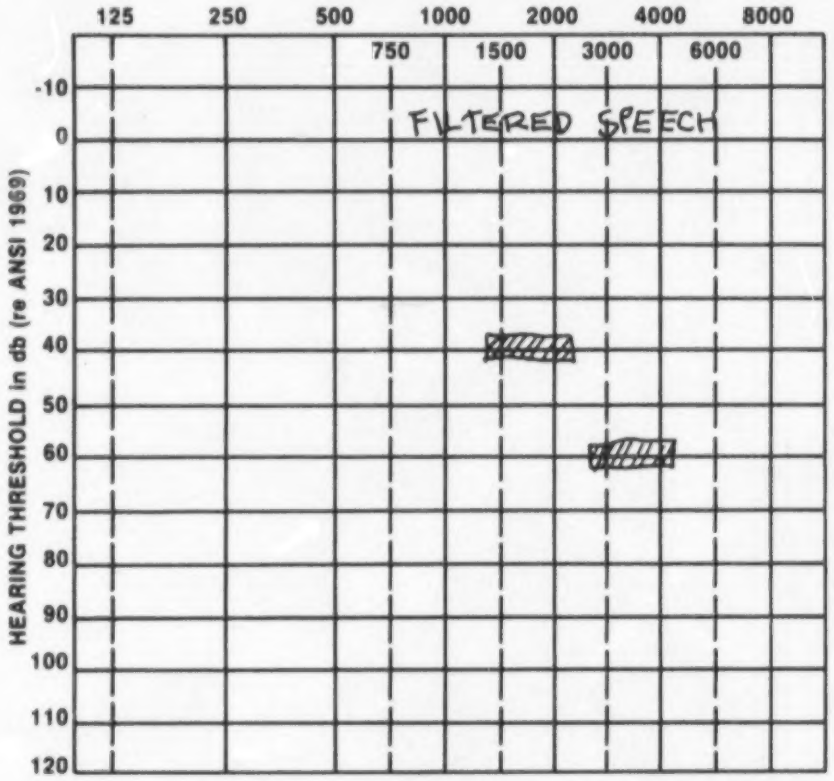


Figure 14

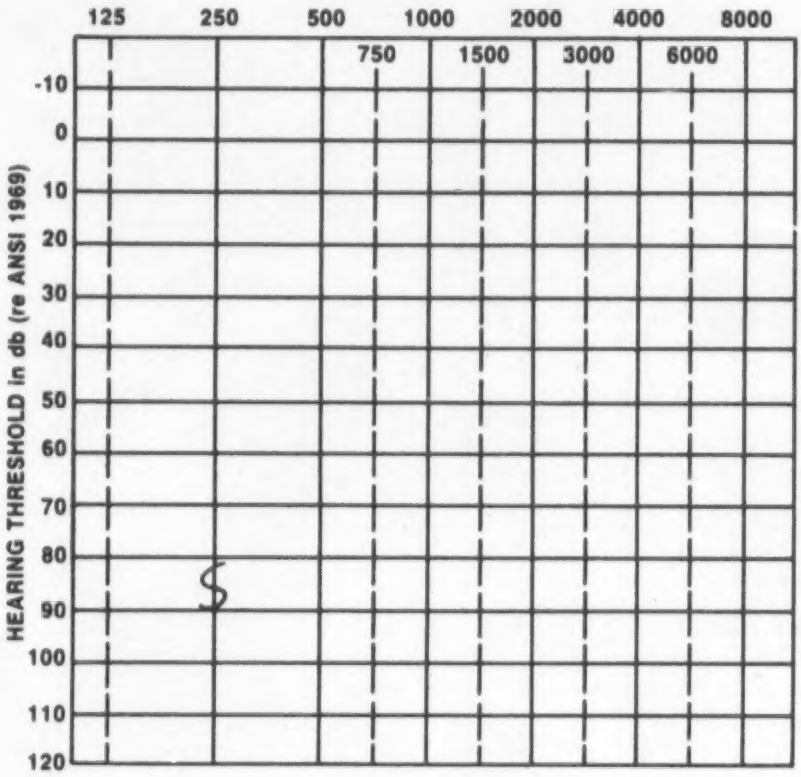


Figure 15

In addition to whatever information is plotted on the audiogram, the audiologist will use a variety of other information in interpreting and evaluating a student's type and degree of hearing loss. The student's speech awareness threshold (SAT), or the faintest level at which a reliable response to a speech signal is observed, can provide useful information. Results of objective tests such as impedance or brain stem audiometry discussed in Section 3 will also be considered, particularly for severely handicapped students who may not respond to complex speech discrimination tasks.

Interpretation of an audiogram is always the job of the audiologist, not the teacher. Understanding the student's audiogram requires personal communication between the teacher and the audiologist. When discussing an audiogram with an audiologist, ask any questions which are unclear to you, including the type of test procedures used, the type of sound stimuli used, etc. If the test results do not specifically state the type of loss (e.g., conductive, sensorineural, mixed) and the dB levels at which reliabe responses were observed, ask the audiologist for clarification.

In addition, discuss with the audiologist the specific recommendations she has. For example, if a student has a conductive loss, a medical examination to determine the cause of the loss will be recommended. If the student has a sensorineural loss, some form of amplification will typically be pursued.

The next section provides basic information about use, care and maintenance of hearing aids. More general discussion of the educational implications of differing degrees of hearing loss is found in Chapter V.

Hearing Aids: Types and Terminology

Electrical Components of the Hearing Aid

All hearing aids have three main components: 1) a microphone, which converts the acoustic signals ("input") coming to the ear into an alternating electrical current; 2) an amplifier, which increases the voltage; and 3) a speaker (called a "receiver") which converts the amplified electrical signals back into acoustic signals. These stronger acoustic signals are the "output" of the aid, which is delivered to the ear of the hearing aid wearer. These components are presented schematically in Figures 16 below.

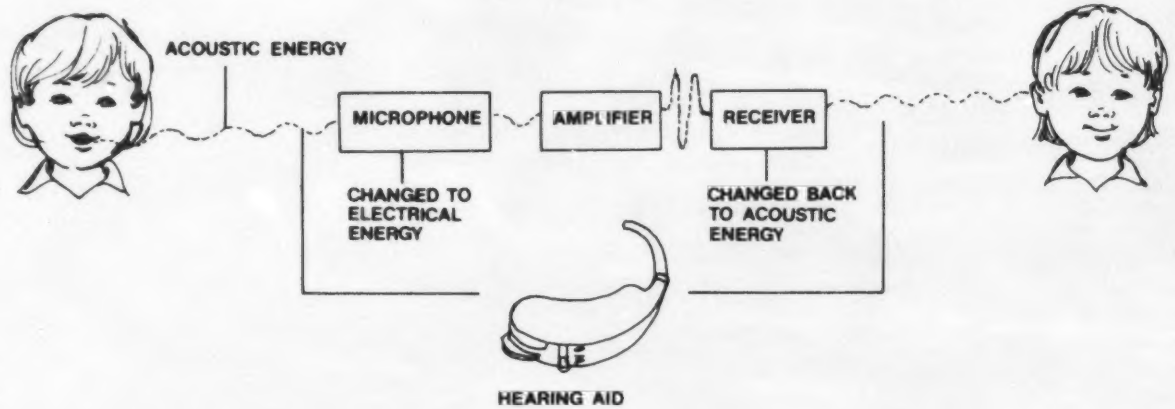


Figure 16

A battery provides the electrical energy needed for the hearing aid to function. In addition, hearing aids are connected ("coupled") to the wearer's ear canal with an earmold. Earmolds may be made from a variety of synthetic materials. Molds made of lucite, a hard clear plastic, are generally easy to keep clean and retain their shapes well over long periods of time. Molds made of softer, more flexible polyvinyl chloride are more difficult to keep clean and may harden and shrink over time. However, the softer molds are often more comfortable and may ensure a closer fit if the user needs a very powerful hearing aid.

Earmolds also come in a variety of standard styles. Depending on the type and degree of loss, some persons will require only a thin piece of tubing in the ear canal; others will need a full mold which fills the entire canal and the inner depression of the pinna (concha). Earmolds can exert a significant effect upon the final acoustic product of an aid (see Smith, 1977, for discussion) and must be carefully selected and fitted by an audiologist or hearing aid dispenser.

Types of Amplification Devices

Body Aids: Body aids generally consist of a comparatively large microphone, amplifier, and battery in a case worn on the body (situated in a pocket or harness worn under the clothing). Power travels from this instrument case through a thin, flexible wire to a receiver attached to an earmold at the wearer's ear. Body worn aids often have greater power output and gain capabilities than ear level aids. They are sometimes recommended for very young children (Northern & Downs, 1978) and persons with profound hearing losses or physical disabilities (Ross, 1976). Children and physically disabled persons may benefit from increased sturdiness and the more easily accessible external controls; persons with profound hearing losses benefit from the increased distance between amplifier and receiver, which reduces problems of electronic feedback (see below).

Ear level aids: Three types of aids are worn at ear level: all-in-the-ear aids (seldom used with children and therefore not discussed here); eyeglass models, and behind the ear models. Behind the ear models are by far the most popular. All the electrical components fit in a small plastic case worn behind the pinna; a small plastic tube connects the case to the earmold. In eyeglass models, the aid is housed in the eye glass frames. In the past, ear level aids were not as powerful as body aids, although this is rapidly changing. These aids are usually less durable, and may require more frequent battery changes. A major problem with ear level aids is acoustic feedback. The major advantage is that sound is picked up at the appropriate place - at the ear. In addition, these aids are less conspicious than body aids and do not pick up miscellaneous clothing noise.

Auditory trainers: The most commonly used auditory training systems are radio frequency (RF) systems. These systems operate as miniature FM radio stations. The teacher wears a microphone around his neck and his speech is broadcasted via the FM signal. The child wears what is essentially a radio receiver that serves as a hearing aid which picks up the signals delivered through the teacher's microphone. RF systems are portable and flexible. In a group instruction setting, all children can receive the teacher's voice simultaneously; for individual instruction, the teacher's microphone is shut off and the teacher speaks directly into individual microphones located on each child's individual receiver. In some cases the child's personal hearing aid can be adapted to an FM unit.

Monaural vs. Binaural Hearing Aids: Monaural aids provide amplification to one ear only; binaural aids consist of a complete hearing aid for each ear. Considerable debate continues as to the relative merits of monaural vs. binaural aids. Northern and Downs (1978) state that children

with bilateral symmetrical hearing loss are the best candidates for binaural hearing aids. Ross (1976) suggests binaural hearing aids for all pre-verbal hearing impaired children. Sweetow (1979) suggests that binaural aids should be tried unless there is a strong reason to suspect that monaural amplification might be superior, i.e., for a child with a large asymmetry between the ears. Selection of monaural vs. binaural aids is an audiological decision based upon a variety of factors; the audiologist should explain the reasons behind her selection of monaural or binaural aids to the teacher.

Hearing Aids: Use and Daily Care

Parts and User Controls

Figure 17 illustrates a typical over-the-ear hearing aid. Dependent upon the type and manufacturer, user controls will vary from aid to aid. Inspect all of the hearing aids used by students in your classroom so that you are familiar with the controls and settings of each.

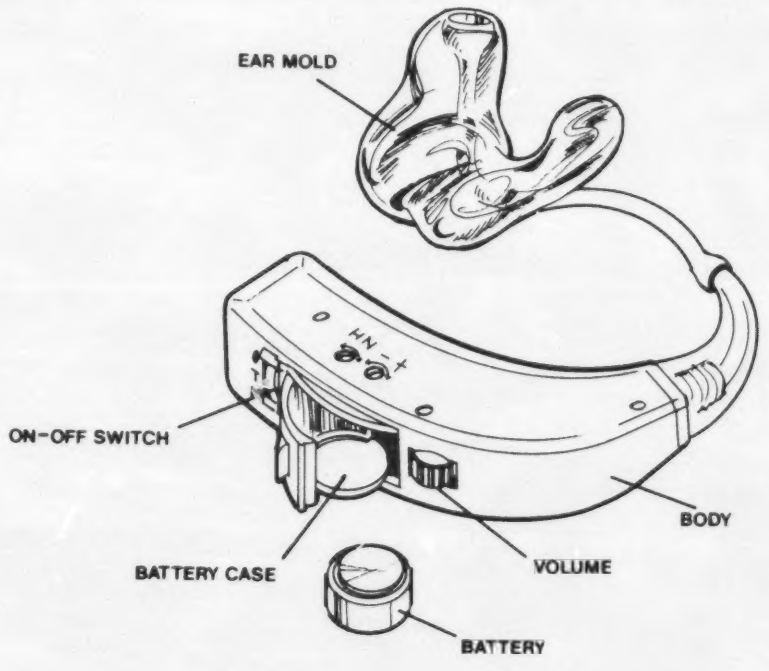


Figure 17

OTM Switch. This is the basic on/off switch of the aid. *O* is off. *M* is *microphone* and indicates the aid is on. *T* is *telephone*, and is intended for use when the wearer is using the telephone. While the majority of aids have these three settings, they can vary dependent upon the type of aid and type of hearing loss. Some aids, for example, may have a *suppression* setting, rather than a telephone setting. This setting specifically suppresses certain sound frequencies. Be sure you know which settings are appropriate for which listening situations so that the student will receive maximum benefit from his aids.

Volume. The rotating volume control increases and decreases the gain (the difference in dB between the unamplified input signal and the amplified output signal) of the hearing aid. The purpose of the volume control is for the user to be able to adjust the volume based on the listening situation he is in e.g., if sounds are too loud, the volume can be decreased. However, many sevrely handicapped students will be unable to change the volume control independently while wearing the aids, and they may also be unable to clearly communicate when sounds are too loud or too soft for comfort. Therefore, ask the student's audiologist to recommend a volume control setting for typical classroom use. It may be helpful to mark this setting on the volume control wheel with a tiny dot of nail polish. Do *not* assume that the volume control should automatically be at the maximum setting.

Batteries. Batteries are inserted in the swing-out-compartment on the aid. The (+) sign on the battery should face the same way as the (+) sign on the aid. Be sure there is no corrosive deposit on the battery or battery compartment. A pencil eraser can be used to remove corrosion. The typical life expectancy of a battery is about 50 to 60 hours of use, but this will vary with each aid, so batteries must be tested daily and changed as necessary (see below). Always have the appropriate kind of extra batteries on hand.

Tubing. The function of the tubing is to connect the aid and the mold. Tubing should be smooth and fit snugly onto both the aid and the mold. It should be checked for cracks and hardening.

Daily Use

Inserting and Wearing Aids. Both parents and teachers should be familiar with procedures for care and maintenance of hearing aids. Some students may arrive at school already wearing their aids and simply keep them in all day. Other students may need to learn to check their own aids and to insert them.

If the student is accustomed to the aids, she will typically wear them all day without interruption. However, if a student is experienceing amplification for the first time, the audiologist may recommend a specific schedule for helping the student become accustomed to the hearing aid.

Tucker and Berry (1980) report a successful training program for teaching deaf multihandicapped adolescents to independently insert, remove, and check their own hearing aids, and the teacher should consider if independent hearing aid use is a potential instructional objective for the student. Still other students will be largely dependent upon others to insert, remove, and care for the aids.

Regardless of whether the teacher, parent, or student is primarily responsible, batteries should *always* be tested daily. Weak or worn out batteries are extremely common and have a direct effect upon the hearing aid's performance. A battery tester is the most simple way to test a battery, and battery testers can be obtained from most hearing aid dispensers.

After the battery has been tested and inserted in the battery compartment, it is helpful to run a listening check on the aid. This requires that the teacher have a personal earmold made so that he can listen to the aid and detect problems or faulty functioning. A listening check is particularly valuable if the student is unable to reliably communicate problems such as a completely dead aid or gross distortion in sound which is uncomfortable to hear. In a listening check the teacher should gradually increase the volume of the aid so that any "dead" spots or static will be noted. The case of the aid should be press-

ed between the fingers to check for loose connections that might result in an intermittent signal. It is useful for the teacher to count aloud from 1-10 so that he might detect any gross distortion of vowel or consonant sounds. The internal noise level of the aid (i.e., the electrical noise generated by the aid when there is no auditory input) should be checked.

After a battery check and listening check, insert the aid by fitting the earmold into the ear. All school personnel working directly with a student should be familiar with how to insert the mold into the ear. A good mold must fit snugly, with no gaps, and should rest securely in the ear. If the mold is improperly fitted or inserted, a "whistling" sound (acoustic feedback) may occur. Once the mold is in, turn on the OTM switch and adjust the volume control.

Removal, cleaning and storage. When the hearing aid is not being used, it should be turned off and the batteries should be removed. Batteries should be stored in a cool, dry place.

The aid itself should be wiped clean with a soft, dry cloth each night when it is taken off. The earmold and tubing should be checked for wax buildup and dirt, as a wax buildup in the canal of the earmold will prevent the sound from getting through. The earmold can be cleaned by soaking it in mild soapy water and washing it with a soft pipe cleaner or a toothpick wrapped in cotton. Never use alcohol or solvents to clean any part of the mold or aid.

Be careful to avoid exposing the aid to conditions of extreme heat, cold, or humidity, such as leaving it on a radiator or in a closed car in the sun. Also avoid dropping or jarring the aid and handle it gently. Do not get the aid itself wet, as water can seriously damage the electronic components.

Troubleshooting

A listening check may reveal an aid that is "dead" or that produces inconsistent or garbled signals. Another frequent problem is a squealing or whistling sound when the aid is being worn. The following is a brief checklist of potential problems and possible solutions that the teacher can try if the problem occurs in the classroom.

If none of these procedures provide a solution, consult the hearing aid dispenser for assistance. Whenever your student's aids must be repaired or checked, be sure to ask for loaner replacement aids to use until the student gets his aids back.

Long term maintenance of aids requires that they be checked at least once a year by the hearing aid dispenser. (Note that this is different from an audiological re-check on the status of the student's hearing.) Additionally, properly fitting earmolds are crucial, and may need to be replaced as often as every 3 to 6 months in a young, growing student.

Recent data suggest that at any given time, as many as 50% of the hearing aids in use in classrooms for deaf children ar not functioning properly (Schell, 1976). It is extremely important that a student's batteries, hearing aids, and earmolds are checked on a daily basis and are maintained in good working order. The teacher and primary caretaker in the home should communicate with one another to be sure that one or the other is monitoring the child's amplification system on a regular basis. In addition to information presented here, the audiologist and/or hearing aid dealer may also be able to provide helpful literature on the exact model and type of hearing aid the student has. Other references that may be particularly helpful to parents include a primer for parents in Northern and Downs (1978), Kukla and Connolly (1978), and Dodds and Harford (1970).

PROBLEM	WHAT TO DO
Squealing, whistling, or feedback	**1. Check if earmold is properly inserted.**
	2. Check if earmold is too loose.
	3. If needed, arrange to get a new earmold made.
	4. Check if the tubing from the mold fits tightly onto the aid.
	5. Do *not* merely turn down the volume control as a means of permanently solving the problem.
Aid is "dead" or intermittent	**1. Replace battery.**
	2. Be sure that battery is inserted with (+) on the correct side.
	3. Check to see if the battery is being firmly held in the compartment.
	4. Check for corrosion on battery contacts and clean with a pencil eraser.
	5. Check if ear wax is plugging the canal of the mold and wash if needed.
	6. Be sure that the OTM switch is not in the telephone or off position.
Scratchy, distorted or weak signal	**1. Change battery, even if you have just done so.**
	2. Rotate volume control and listen for scratchy or dead spots.

V. Educational Implications: Classroom Follow-up and Functional Auditory Programming

The guidelines in Table 5 below are generally appropriate for students whose *sole* disability is a hearing impairment. They provide a general frame of reference for teachers of severely handicapped students in evaluating the potential implications of a student's hearing loss for educational programming. It is crucial to realize, however, that the effects of a hearing loss are compounded when additional disabilities are present. The presence of multiple other disabilities such as retardation, cerebral palsy, blindness, etc. may alter these guidelines considerably. For severely multiply handicapped students, implications of a hearing loss will therefore be highly individualized and require thoughtful discussion between teacher, audiologist, speech therapist, and other personnel. Such transdisciplinary information will play a crucial role in each area of classroom follow up discussed below.

Classroom Follow-Up:
Selecting Instructional Objectives

After accurate audiological assessment, each student requires a carefully designed, individualized instructional program for communication and auditory skill instruction. Selection of a basic communication mode (e.g., speech, sign, visual symbols, etc.), is a complex process that is highly dependent upon each student's skills and disabilities. The details of this process are beyond the scope of this manual, but Sailor, Guess, Goetz, Schuler, Utley, and Baldwin (1980), Shane (1979), and Schuler & Goetz (1981) provide some general guidelines for selecting appropriate communication modes for severely multiply handicaped students. Beyond this, as stated above, selecting a communication mode is highly individualized and dependent upon transdisciplinary assessment information, the communication modes used in the student's present and future environments, and numerous other factors.

If speech appears to be a primary candidate as an instructional mode, Guess, Sailor, and Baer (1976) offer an extensive speech training program for severely handicapped students. If signing appears to be a major possibility, Stremel-Campbell, Cantrell, and Halle (1977) may be a helpful resource. If communication devices are a major possibility, the reader is referred to Vanderheiden and Grilley (1977).

In addition to determining a basic communication mode, the teacher will also have to determine appropriate specific auditory and communication objectives for the student. For example, if a student has been provided with aids for the first time, he may need a program to teach him to wear the aids on a consistent basis. Other students can be taught to test and load their own batteries, put in their aids, and perform other maintenance functions (cf. Tucker and Berry, 1980). For students with more than a mild loss, it is recommended to repeat the OMR or VRL program (see Section III) while wearing the aids, both to assist the audiologist during subsequent re-evaluations and, if needed, to teach the student some consistent responding to auditory cues for the first time.

Other specific auditory training objectives, such as localization to sound, speech discrimination, or auditory comprehension, are determined on the basis of assessment scales and assessment information from the transdisciplinary team. Again, selection of specific auditory skills for instruction is highly individualized and student specific and is therefore not discussed in detail here.

However, once you have evaluated the available assessment data, be certain to discuss your recommendations for auditory training, speech comprehension and expression and/or alternative communication modes in detail with the speech therapist and audiologist. Be very specific, outlining explanations of the student's hearing abilities, assessment data, and suggested methods of programming. Then, in conjunction with the strategies below, write up and implement the instructional programs.

General guidelines of educational handicap as a function of hearing loss (Hearing level dB ANSI-1969 reference).

Loss in dB	Severity of handicap	Probable needs
0 to 19	Normal	Probably will not present any significant educational handicap.
20 to 35	Mild	Has difficulty hearing faint speech. May require preferential seating in the classroom and may benefit from amplification.
36 to 55	Moderate	Can understand normal conversational speech at 3 to 6 feet; needs hearing aid, auditory training, preferential seating, speech and language training.
56 to 70	Moderately severe	Great difficulty understanding conversational speech. Requires all of the above services and may benefit from initial placement in class for the hearing impaired.
71 to 90	Severe	Will not hear normal conversational speech without amplification; may identify loud environmental noises; needs amplification and services as outlined above.
91 plus	Profound	Auditory abilities limited even with amplification. Will need to rely largely on additional sensory input. Extensive special education required.

Table 5

Functional Auditory Programming

The following sections outline a model for implementing auditory programs in the classroom. After program decisions discussed above (selection of a basic communication mode and selection of specific auditory and communication objectives) are made, use the strategies below to construct a system of instructional delivery. The model proposed here entails two basic components: 1) use of functional curricular content and 2) use of the individual curriculum sequence (Holvoet, Guess, Mulligan and Brown, 1980). The model is dependent upon standard operant teaching practices, use of task analysis as the basic instructional strategy, and data based instruction and decision making (cf. Snell, 1978; Haring, et. al., 1980; Donellan, Gossage, LaVigna, Schuler, and Traphagen, 1977).

Functional Curricular Content and Materials

Content. As discussed by Holvoet, et al., (1980), a first step in developing functional auditory programs is to translate standard auditory assessment items into functional skills. Functional skills are skills that will directly contribute to increased independence for the student in his home, school, and community environments. Most assessment scales are based upon normal patterns of child development and outline a series of items which are indicative of presumed underlying skills (cf. Griffin and Sanford, 1975). For example, an assesment item might read, "smiles when talked to." Two of the presumed underlying skills might be recognition of a specific auditory stimulus and possible comprehension of some speech messages. However, rather than teaching the student to smile when talked to, and reinforcing smiling behavior, a more functional objective might be to teach the student name recognition as a cue to begin moving to the table for lunch or as a cue for a systematic tactile scan of the desk top in search of a toy.

When deciding what functional skills to teach each student, consider the usefulness of each auditory or communication skill and how often it must be used in various environments (Brown, Branston-McClean, Baumgart, Vincent, Falvey and Schroeder, 1979). Ask yourself when, how, why and in what contexts the student will need to demonstrate any particular auditory skill. One method is to take an environmental inventory of the most common environments in which the student functions (Brown, et al., 1979). Find out what things the student needs to know to function more independently in those environments. For example, if a student learns that ringing of the bell on the toaster oven means the toast is ready to be buttered, this student is a step closer to independent functioning at breakfast. If she learns that ringing a buzzer on her communication board will bring a peer to assist her on and off an adaptive bicycle, leisure skills are one step closer to independence.

By looking at assessment items, their underlying skills, and the skills likely to be used in daily life, the teacher can generate many functional approaches to teaching the same basic skill during many daily situations. As a further example, an assessment item might read: "responds to own name." Many different kinds of responses to one's name are possible, and the teacher should think about when, where, and why it is important to respond to one's name. The student's natural environment would probably not require responding to her name 10-15 times in succession. Rather, when a persons's name is called in a natural situation, some other event is likely to follow, such as being handed a stack of dishes to wash, or walking to the speaker to participate in a joint social or independent living activity. Thus, the objective "responds to own name" might be made more functional if it is translated into "responds with localization to name in order to 1) shake hands with peer; and 2) walk to seat at lunch table."

The rationale for selection of functional curricular content for severely handicapped students has been discussed in detail elsewhere (cf. Holvoet, et al., 1980). Brown, Branston, Hamre-Nietupski, Pumpian, Certo, and Gruenewald (1979) have discussed functional content across curricular domains, and Goetz, Schuler, and Sailor (1981) have reviewed the available research supporting use of functional content in initial communication instruction. A major factor lending support to teaching functional skills needed for increased independence is the failure of most severely handicapped students to generalize learned skills outside of the training environment (cf. Stokes and Baer, 1977; Harris, 1975). Thus, valuable teaching time is lost when specific assessment items are taught in an isolated classroom context, and then must be retrained before they are used in natural contexts and for natural purpsoes. By translating assessment items into functional skills *before* beginning instruction, much teaching time should be saved.

Materials. As discussed by Holvoet, et al., (1981) and Brown, et al., (1979), once auditory and communication assessment items have been reformulated into functional objectives (objectives which increase the student's independence in his natural environments), the second step in functional auditory programming is to consider the materials used to teach the skill. In order to teach auditory and communication skills in functional contexts, the materials must be "real" and age appropriate. Functional materials are age appropriate materials the student will actually encounter in daily life situations. Thus, a severely handicapped low vision adolescent will not need to learn to orient to and operate a child's music box or "see and say" pulltoy. The same student, however, could learn to orient to auditory cues and to produce auditory stimuli by using a cassette tape recorder with age appropriate music as the teaching stimulus. Similarly, the sound of a spoon in a bowl is a functinal cue for teaching a reach response as part of a self feeding program, while the use of a squeak toy for the same purpose is less functional.

Once functional materials have been identified, they can be used in numerous ways. Several sets of materials can be used to teach once particular skill, and one single set of materials can be used to teach many different skills. For example, a student could learn to localize to many different sounds and voices (many materials for the same skill); in addition, a student could be taught to localize to a tape recording of music, reach and grasp the push-switch, turn the tape recorder on again, and vocalize to the sounds (many skills with the same item).

Table 6 below gives some further examples of assessment items translated into functional objectives and the materials which could be used to teach those objectives.

TABLE 6

SAMPLE ASSESSMENT ITEM	SAMPLE FUNCTIONAL OBJECTIVE	SAMPLE FUNCTIONAL MATERIALS
-attends to teacher's voice when name is called.	1. orients to teacher-speaker in order to perform a task in small group instructional setting.	1. teacher's actual voice and materials related to other instructional tasks.
	2. orients to peer-speaker to pass a leisure item.	2. peer's actual voice and age-appropriate leisure item such as frisbee.
	3. orients to adult-speaker in order to receive food items in cafeteria line.	3. food service worker's actual voice and actual daily menu food items.
- discriminates among common sound sources	1. opens dryer when buzzer signals end of cycle.	1. dryer and clothing items in kitchen or laundromat.
	2. removes whistling tea kettle from heat source.	2. tea kettle, stove, tea bag, instant soup, jello, etc. to mix with hot water.
	3. scans for food or drink item after hearing wrapper being removed or liquid being poured.	3. actual food and drink items in context of self help skills (blind student acquiring independent eating skills) or independent living skills (setting a table or passing food).
- follows one word directions.	1. stands up upon request "stand" in order to move to different work space or task.	1. teacher's voice used for each transition throughout student's day.
	2. puts objects in containers upon request, "in," when finished using or manipulating the items.	2. toothbrush into cup, utensils into dishpan, clothes into hamper, bean bag into target area, lunch materials into bucket.
- uses manual signs to express basic wants and needs.	1. labels desired object or action before engaging in activity.	1. label brush before brushing hair; swing before swinging; music before turning on radio.

Individual Curriculum Sequencing

To implement functional auditory and communication objectives in the classroom, use of the individual curriculum sequencing model is recommended (Holvoet, et al., 1980). A functional individual curriculum sequence is characterized by a carefully arranged series of functionally related skills that are taught in the same session in a "natural" or "common sense" order. Instructional trials on a given skill are distributed throughout the session and day, rather than massed together in one session. The sequence model stresses the interrelationships of skills and the clustering of those skills within training sessions, rather than teaching each skill in isolation using massed practice.

To contrast curriculum sequencing with traditional instructional delivery, consider four hypothetical objectives from a severely handicapped student's IEP, including receptive speech discrimination as a communcation skill:

1. receptive identification of 5 nouns (communication)
2. put on shirt and coat independently (self-help)
3. use pincer grasp to manipulate items (fine motor)
4. use switch operated wheelchair independently (mobility)

The first step in teaching each objective is to write a task analysis. Then, according to traditional methods of organization, these objectives might be taught in the following schedule:

9:00 - 9:30 - dressing skills
(10 trials of "shirt on" followed by 10 trials of "jacket off.")
9:30 - 10:00 - communication skills
(15 massed trials of "point to shoe/pants/coat.")
10:00 - 10:30 - fine motor
(10 repeated trials of using pincer grasp to zip up laundry bag)

Each skill area is thus taught in isolation from other skill areas, using a repeated trial format.

In contrast, using an individual curriculum sequence model would also require task analyzing each skill, but the skills would then be sequenced within instructional sessions. Sample sequences using the same skills are indicated below:

9:00 - 9:30
1. use pincer grasp to unzip clothes bag containing clothes
2. receptively identify specific clothing items
3. put on the identified item

9:30 - 10:00

1. receptively identify chair/table/coat
2. activate chair switch using pincer grasp
3. travel to door
4. put on coat

Each skill is still taught according to its own task analysis, and each entire sequence may be repeated several times within a session. However, because skills are taught in a sequence, instructional trials on any one skill are distributed, rather than massed, and the skills are experienced in a natural "real life" relationship to one another.

Empirical support for the use of individual curriculum sequencing is drawn from several sources. Research on the effects of massed, distributed and spaced practice has been reviewed in detail by Mulligan, Guess, Holvoet, and Brown (1980), who conclude that although much of the available data has been obtained using nonhandicapped learners, in general some form of spaced or distributed practice appears to produce superior learning when compared to massed practice. Numerous other investigators working with severely handicapped students have also reported favorable effects of varying instructional trials and/or distributing practice trials, including superior generalization of motor and discrimination tasks (Panyon and Hall, 1978), genralization of trained expressive signing skills (Gee and Sailor, Ref. Note 2), and acquisition of receptive speech discrimination and labeling skills (Dunlap and Koegel, 1980; Goetz, Ref. Note 3).

In addition to support from these studies, use of functional individual curriculum sequencing as an instructional delivery system for auditory and/or communication objectives is also supported on logical grounds. Auditory stimuli rarely occur in isolation. In the natural environment, an auditory or communicative stimulus occurs and some functional event is the result. Rarely do we turn our head to a speech cue five times in a row in order to be told, "Good, you turned your head." Rather, we localize to a speech source and some functional event follows: we engage in a conversation; receive an object, avoid a dangerous obstacle, etc. Use of an individual curriculum sequence format allows the teacher to utilize natural and functional events as an integral part of auditory and communication training: the student asks for his toothbrush in order to use it; he turns to the sound of his name in order to receive a desired object from the speaker, which he can then use or manipulate in some appropriate way.

Constructing sequences. Developing individual auditory and communication sequences in the classroom requires that classroom staff first translate assessment items into functional objectives with functional, age-appropriate materials identified for use during instruction. Task analyses are then written as usual for each objective.

The teacher must then look at the entire list of objectives for each student and cluster them into various groupings that will allow instruction on the auditory or communication skill to occur in "natural" situations. Grouping the objectives together sensibly mainly requires consideration of 1) which skills can be taught using the same materials (e.g., a toy may serve as the stimulus item for an expressive communcation response, a fine motor manipulation response, and a social response of handing the item to another student), and 2) what life situations will require the student to perform several of the skills together (e.g., independent participation in roller skating on the playground will require numerous communication, gross and fine motor, and social skills).

Instructional sessions must then be organized across the day in such a way as to provide sufficient practice on each skill while at the same time distributing trials in a common sense order. If an auditory localization skill, for example, is taught in only one sequence, and the sequence is only performed once throughout the entire day, it is doubtful the student will have sufficient learning opportunities to actually acquire the skill. Rather, the skill should be taught as part of several different sequences, or the sequence containing the skill should be repeated several times throughout the day.

As an example, consider the following four objectives taken from a total of 10 objectives on a student's IEP:

1) walk 20 steps with support at hips (gross motor)
2) grasp, carry, and release small objects (fine motor)
3) stand and hold onto bar (gross motor)
4) localize to name (auditory/communication)

These four objectives are selected because they could form a natural common-sense sequence of behaviors involving an auditory localization skill for the student:

1) walk to chair (to join small group instruction session)
2) localize to name (name serves as a cue to the student that it is her turn)
3) stand up (in order to perform fine motor task)
4) reach, grasp, and carry (using age-appropriate, functional materials)

The four objectives thus constitute one individual curriculum sequence.

The sequence itself is taught during two different instructional sessions. At an 11:30 session, the student's task is to load a lunch bucket with eating utensils before going to the cafeteria for lunch. At a 2:20 session, the student's task is to load small clothing items from a chest of drawers into a clothes bag. The same skills are thus experienced across different training environments and materials, and the auditory localization skill is learned in a real-life, common sense context.

Within each session, the sequence itself is repeated 5 times. The student first walks to the session following the appropriate step on the task analysis. Thereafter, each time it is her turn, she is required to localize to her name, stand up, and complete the fine motor task. Again, each of these skills is taught according to its own task analysis. Becuase the sequence is used during two instructional sessions, with 5 trials (repetitions of the sequence) during each session, the student receives a total of at least 10 instructional trials on each skill. However, rather than being massed into one session, these trials are distributed in time.

Data Collection for Sequences. Once a sequence has been developed and appropriate times and settings for instruction have been selected, the next step is to design a data sheet that eases the process of summarizing and graphing performance data. Continuing with the above sequence, a sample data sheet for the sequence is found on page 42.

At the very beginning of the 11:30 session the student walks to the cupboard area and sits down. The data for walking is recorded in the top square of the first column. When it is her turn for further instruction, the teacher calls her name and then records the student's response as correct or incorrect according to the step in the task analysis. The response is recorded in the second square of the first column. The teacher then assists the student to stand and reach the bar attached to the counter area. The student is then required to stand for a designated period of time. Performance is recorded in the third square of the first column. While standing, the student uses alternate hands to pick up the utensils or cups and put them in a container. Two trials of the fine motor skill are given and data are recorded in the bottom (slashed) square of the first column. Then this student's turn is over and the teacher moves on to another student.

Each vertical column under the 11:30 and 2:30 sessions thus represents one "turn" or trial for the student. The student's "turn" is done at the end of the vertical column unless indicated otherwise. The staff person returns to the top of the next vertical column when resuming instruction for this student. The squares

Name: Shelley Programs: Gross and fine motor, auditory

Walk with support at hips:
Step: 2 - same as step 1, except do not manipulate the walking motion at the hips, only give the cue and gently push forward. She must take 10 steps for (+).

Stand holding bar: Step: 7
40 seconds for a plus.

Localize to sound of name:
Step: Procedure (A) Step 3C to start - Light and sound together with dull flashlight; probes to sound alone

Grasp, carry: Part B-Put in:
Step: 3 - same as step 2, except assist her only to remind her to pick up the object and prompt her toward container. She must put it in for (+)

Date: 2/7 Materials→	cupboard & counter area, utensils, & container					chest of drawers, clothes and bag						
Task ↓ Time →	11:30					2:20					#C	%
Walk with support	—					+					1	**
Localize to name	—	+	—	+	+	—	+	+	—	+	6/10	60%
Stand holding bar	+	—	—	—	+	—	—	+	+	+	5/10	50%
Grasp, carry, put in	+/—	—/+	+/+	—/+	+/+	+/+	—/—	+/—	+/+	+/+	14/20	70%
Date: Time →	11:30					2:20					#C	%
Walk with support												**
Localize to name											/10	
Stand holding bar											/10	
Grasp, carry, put in	/	/	/	/	/	/	/	/	/	/	/20	
Date: Time →	11:30					2:20					#C	%
Walk with support												**
Localize to name											/10	
Stand holding bar											/10	
Grasp, carry, put in	/	/	/	/	/	/	/	/	/	/	/20	
Date: Time →	11:30					2:20					#C	%
Walk with support												**
Localize to name											/10	
Stand holding bar											/10	
Grasp, carry, put in	/	/	/	/	/	/	/	/	/	/	/20	

** = add to data taken during other sessions and summarize

which have been shaded indicate to the staff person not to have the student perform that skill, but to go on with the rest of the sequence. In this sequence, for example, the walking skill is performed only at the start of the first turn, and is skipped on the remaining four turns in the session.

The performance data recorded on this sheet indicate that on the first trial of the 11:30 session,the student did not perform correctly on the walking skill (−). The student also did not localize correctly (−). However, she did stand for the required amount of time (+), and correctly grasped, carried, and released an object on one of two trials given on this skill (+/−). On the fourth trial of the 11:30 session, for example, the localization response was correct, standing holding the bar was incorrect, and again one of the two trials of reach, grasp and carry was correct.

Note again that each skill in this sequence has its own task analysis, and that criteria for correct and incorrect responses are specified in the analyses. (See the following pages for the task analyses for each skill in this sequence.) This student is on step 2 of the task analysis for walking, step 3c of the analysis for localizing to sound, etc. Space is left at the top of the data sheet to indicate the current step of each skill.

To summarize data at the end of the day, scores are summed across the horizontal row for each skill. Thus, in the row of scores for localization, the student scored a correct response (+) on the second, fourth and fifth trials (during the 11:30 session) and on the seventh, eighth and tenth trials (during the 2:30 session). The student's performance for the day is therefore 6 out of 10 trials, or 60%. This information is plotted on a graph for the localization skill. Similarly, the data recorded in the row for "standing holding bar" shows 5 out of 10 correct responses (on the first, fifth, eighth, ninth, and tenth trials), or 50% correct for the day. This score is again plotted on a separate graph for the standing skill. The 70% correct for the reach, grasp, and carry skills is also plotted on its own graph.

However, the daily data for the walking skill is not completed in these two instructional sessions. The student is required to walk to a total of 10 different instructional sessions throughout the day. Therefore, the number of correct trials (#C=1) from these two sessions is added to the number of correct responses obtained from other sessions throughout the day. The percentage is then calculated from the total of the 10 trials across different instructional sesions (**). This percentage is then graphed.

Sample Task Analyses. To provide a complete example of the process of constructing this functional auditory sequence, task analyses for each of the skills in the sequence are provided below.

Skill #1: Walking with support. Table 7 presents the task analysis for the first skill in the sequence: walking with support at the hips. The analysis follows a simple prompt fading procedure. Walking opportunities are provided at the start of numerous different functional sequences. Two walking opportunities (one at 11:30 and one at 2:30) are provided as part of the functional auditory sequence discussed above.

SKILL 1 - SUPPORTED WALKING

Behavioral Objective: **Given support at the hips, the student will take at least 20 out of 25 steps without dropping forward or lifting her legs for at least 80% of the opportunities given throughout the day on 3 out of 5 days.**

Setting: **Home, classroom, hallways.**

Materials: **Chair or other piece of furniture that moves easily while the trainer sits and walks with student.**

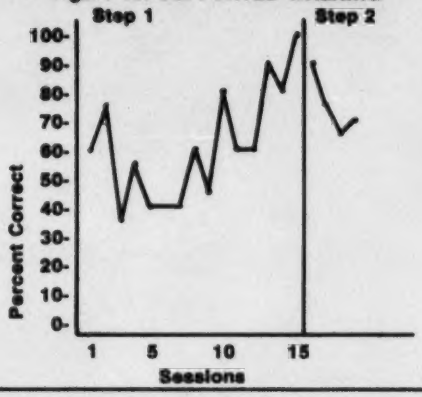
Teacher Does	Student Does
1. Sit on a chair or other item that will slide along easily. Place the student in a standing position between your knees. Grasp her firmly at the hips and prompt her to walk by manipulating her at the hips in a walking motion. Reinforce and count as a (+) only steps which are made without dropping forward, lifting legs up, or putting one leg on the other. Provide 25 steps.	1. The student must make 10 walking steps without dropping forward, lifting legs up, or placing one leg on the other.
2. Same, except do not manipulate the walking motion at hips. Instead, give verbal cue again and gently push forward.	2. Same.
3. Same, except only hold hips, give no assistance to make walking movements.	3. Same.
4. Same	4. The student must make 15 out of 25 steps.
	5. The student must make 20 out of 25 steps.

Table 7

If walking opportunities are provided at the start of a total of six different instructional sessions throughout the day, and the student meets the specific step criterion (e.g., step 2- walk 10 steps with the faded prompt) on four of these six opportunities, the student's percentage for that day is 4/6 or 66%. This percentage is then graphed.

Following this process, performance data for the first two steps of this analysis are graphed in Figure 18. Figure 18 indicates that the student required 15 days to meet criterion on step 1, and then moved to step 2.

Figure 18: SUPPORTED WALKING



Skill #2: Functional localization. The task analysis for functional localization, the second skill in the sequence, is found in Table 8. Two alternative procedures are described. In one, the intensity fading procedures of the VRL program are used with a flashlight as the light source. In the second procedure, a time delay strategy is used.

SKILL 2 - Functional Auditory Localization (Adaptation to VRL)

Objective: **When the student's name is called or some other functional speech or auditory cue is given, the student will demonstrate localization or orientation to the cue by a designated reliable response (i.e., head turn, reliable eye response, arm movement, etc.) on at least 80% of the trials for 3 out of 5 days.**

Materials: **flashlight or other paired stimulus materials, auditory cue if other than speech, data sheet, pencil.**

Setting: **classroom - in group or individual sessions; home.**

General Procedures: **There are 2 possible procedures shown below. The first follows the same format as one of the programs to prepare studennts for auditory assessments - VRL, or Visually Reinforced Localization. The light and sound stimuli are paired and the light is gradually faded while probes to sound alone are intermittently run until they reach 90%. The student then moves to auditory stimulus alone with the light as a reinforcer. The second procedure uses the same basic stimulus shift but rather than fading the light intensity, a time delay strategy is used to make the shift occur. Refer to the VRL program for more details on the procedures and on various adaptations.**

Teacher	Student
- Take baseline data on auditory cue alone.	- *Baseline:* must make the designated response to sound alone independently.
- For each step below: Position yourself to deliver auditory cue from right or left as designated on data sheet. Deliver stimulus & reinforce, being ready to move right into next task, demonstrating functional relationship between localizing and whatever follows.	
1. Train student to turn to flashlight (or other paired stimulus) using similar procedures as in VRL.	1. The student must turn head or give other designated response to the light with 80% accuracy on 3 out of 5 days.
- Students who went through VRL program may not need training on light alone.	
2. Pair the flashlight with speech or other auditory cue giving them at the exact same time.	2. The student must give the same response to the paired stimuli. Same criteria.
3. Begin to fade the flashlight intensity still pairing each trial with the auditory cue. Depending on the method used to fade the light, number the steps 3a, 3b, 3c, etc. as the light gets dimmer.	3. Same as in #2.
- Probe intermittently using the sound stimulus alone & reinforcing with the light.	- Probes: the student must make the same response to the auditory cue alone to criteria before moving on to step 4.
4. Give auditory stimulus alone. Fade reinforcement schedule to natural reinforcers.	4. Same response to criteria.

Objective Complete

Data: **Record two percentage scores. One score represents first turning to light and then the varying degrees of light plus sound. The other score on the graph should represent the probes to the auditory stimulus alone.**

Table 8

SKILL 2 - FUNCTIONAL LOCALIZATION Con't.

B.) Time Delay - gradually increase the amount of time between the cue and the prompt until an anticipated response results.

Teacher	Student
- Take baseline data on sound stimulus alone.	- *Baseline:* must make the designated response to sound alone independently.
- For each step below: Position yourself to deliver auditory cue from right or left as designated on data sheet. Deliver stimulus & reinforce, being ready to move right into next task, demonstrating functional relationship between localizing and whatever follows.	
1. Train the student to turn to the light alone similar to VRL program.	1. The student must turn head or give the designated response to the light with 80% accuracy on 3 out of 5 days.
- Students who went through the VRL program may not need training on light alone.	
2. Pair the flashlight with speech or other auditory cue giving them at exactly the same time.	2. The student must give the same response to the paired stimuli.
3. Begin the time delay by presenting the auditory stimulus first & then the light stimulus, gradually increasing the number of seconds between the auditory and light cues. 3a. 1 second delay b. 2 second delay c. 3 second delay d. 4 second delay e. 5 second delay	3. The student must give the same response to the paired stimuli and then to the auditory stimulus alone to the same criteria for each part below. 3a. 1 second b. 2 seconds c. 3 seconds d. 4 seconds e. 5 seconds
- continue up to 12 seconds.	
- score a (+) if the student waits for the light & responds correctly; score a + if the student responds before the light stimulus is given (anticipates): and score a (–) if there is no response.	
- If after the 12 second delay, the student is still not getting the anticipated responses better than 50%, go back to 3a and try again; then use data to determine if another strategy would be better.	
- fade reinforcement schedule to natural reinforcers when #3 is passed.	

- Objective Complete -

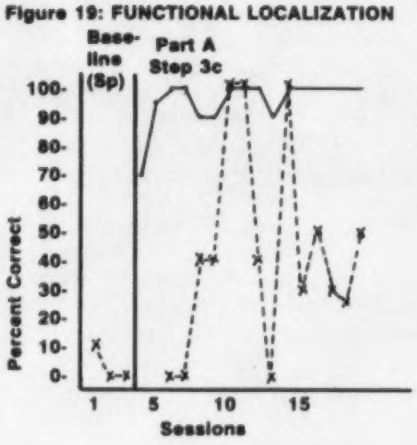
Data: **Two lines should be shown on the graph: one representing the percentage scores of first light alone, then paired light & sound including the times when the student waits for the light during step #3, and the second line representing the percentage scores for responses to sound alone (+).**

Table 8 con't.

A total of ten opportunities for localization are provided each day. Five trials are given during the 11:30 session of the sequence, and five trials are given during the 2:30 session. The total correct out of ten trials is then plotted on a graph.

Figure 19 presents sample performance data from the same student on the localization skill. The procedure used was the intensity fade. Responses to the paired light and auditory cue are indicated by •-•-•, and probes to the auditory cue alone are indicated by x-x-x.

Figure 19: FUNCTIONAL LOCALIZATION



The student is responding reliably to the paired stimulus but is not yet responding consistently to the auditory probes.

Skill #3: Standing at a bar. The third skill in the sequence is standing at a bar. The task analysis for this skill is found in Table 9. As with the localization skill, performance data from the two sessions in which the sequence is performed are combined each day and plotted on a graph such as the one in Figure 20 on the following page.

SKILL 3 - STANDING AT A BAR

Behavioral Objective: **Given a bar at shoulder height in a horizontal position and assistance to rise to stand and grasp bar, the student will be able to hold on and support herself at the bar with alternate hands for at least 2 minutes to a criteria of at least 80% on 2 out of 3 days.**

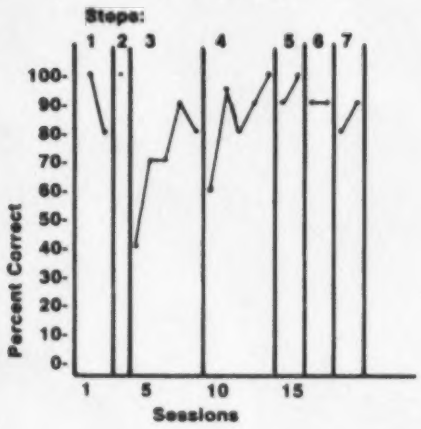
Materials: **chinning bar securely fastened.**

Setting: **classroom or home.**

Teacher Does	Student Does
For each step: **Assist the student to rise to stand and grasp bar with both hands, placing her feet in a good position.**	
1. Reinforce while standing.	1. The student must keep alternate hands on bar for at least 2 seconds.
2. Same as above.	2. Same, but 5 seconds.
3. Same as above.	3. Same, but 8 seconds.
4. Same as above.	4. Same, but 10 seconds.
5. Give no support. Reinforce only non-supported standing.	5. Same, 15 seconds.
6. Same as #8.	6. 30 seconds.
7. Same as #8.	7. 40 seconds.
8. Same as #8.	8. 60 seconds.
9. Same as #8.	9. 2 minutes.

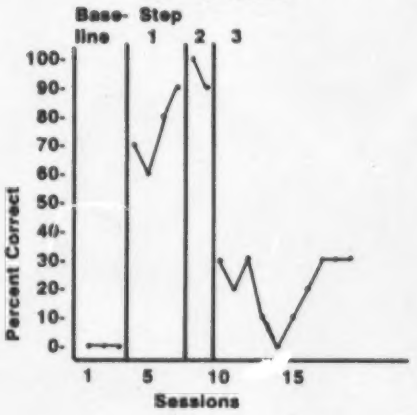
Table 9

Figure 20: STANDING AT A BAR



Skill #4: Reach, grasp and carry. The final skill in the sequence is a fine motor skill of reaching, grasping, and putting in. Part B of this program, putting objects into containers, is task analyzed in Table 10 below. This analysis uses a prompt fading procedure. Again, a total of 20 trials are given across the two instructional sessions and these data are summarized into a single daily score. Figure 21 is a sample graph of data from this program. The student rapidly met criterion on steps 1 and 2 and is now working on step 3 of the analysis.

Figure 21: REACH, GRASP, AND CARRY ITEMS



SKILL 4 - REACH, GRASP, AND CARRY ITEMS

Part A: complete
B: Put in

Behavioral Objective: **Given items which easily fit into open, varied containers and the verbal, signed, or demonstrated (if no other system is used) cue, "Put in," the student will be able to put a group of at least 5 items into a container, to a criteria of 80% accuracy on 2 out of 3 days.**

Materials: **Functional items and their containers, play items and containers.**

Setting: **Classroom or home.**

Teacher Does	Student Does
For each step: place the container and items on the work surface. Give the verbal and/or signed cue, "Put in," or the demonstrated cue to put in if no other communication system is used.	
1. Place one of the student's hands on the container and assist him/her to pick up an object and lift it to the container resting the student's wrist on the container.	**1. The student must release the object, dropping it into the container.**
2. Same as above except assist the student only to lift up the object and bring it to the opening of the container.	**2. The student must place the object in the container.**
3. Same, except assist the student only to pick up the object and prompt toward the container.	**3. Same as #2.**
4. Same, except assist the student only to pick up the object.	**4. Same.**
5. Same, except give just a slight prompt at the student's hands to begin and no further assistance.	**5. Same.**
6. Give no prompt.	**6. Same.**
7. Prompt to do a second object.	**7. The student must put one object in and a second after the prompt.**
8. Give no prompt.	**8. The student must put 2 objects in the container.**
9. After the student puts 2 items in, give prompts as necessary during training to keep going to at least 5 items. The student should receive a (+) only on the trials in which s/he completes at least 5 items in a row.	**9. The student must put at least 5 items in the container without assistance.**

Table 10

The aim of the above examples is to emphasize that although several skills are taught together as part of one sequence, each individual skill progresses according to its own task analysis and criteria, and the data for each skill are plotted separately. Thus progress in a sequence involving four skills, such as the localization sequence above, is monitored through four different graphs.

The sequencing model outlined here is appropriate for teaching a broad array of auditory and communication skills, ranging from receptive and expressive labeling to auditory recognition of common environmental sounds to hearing aid use and maintenance. Regardless of what the specific skill is, instruction in a sequenced format should provide the student with numerous opportunities throughout the day to learn useful skills in natural contexts. The result should be auditory and communicative behaviors which are genuinely functional for the student.

Reference Notes

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